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ABSTRACT

The conference reported in this document provides a meeting place for researchers from around the world, where the emphasis is on new ideas connected to computer technologies in education. This volume contains 140 extended abstracts selected by the program committee and organized into the following categories: (1) educational informational technologies (14 titles); (2) multimedia and hypermedia learning environments (24 titles); (3) distance learning (14 titles); (4) knowledge-based systems in education (23 titles); (5) intelligent tutoring systems and their components (19 titles); (6) student modelling (10 titles); (7) simulation environments and teaching science (15 titles); (8) teaching languages and humanities (7 titles); and (9) teaching programming (14 titles). The articles have been prepared by and are of interest to researchers in artificial intelligence, cognitive science, and education; computer scientists and information technologists; teachers, educationalists, and psychologists; and anyone else concerned with educational innovations. (JLB)

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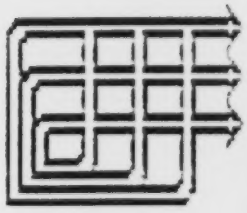
Computer Technologies in Education

Proceedings of the International Conference on Computer Technologies in Education (ICCTE'93)
Kiev, Ukraine, September 14-17, 1993



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Computer Technologies in Education

Proceedings of the International Conference on Computer Technologies in Education (ICCTE'93)
Kiev, Ukraine, September 14-17, 1993

Kiev - 1993

Preface

The International Conference on Computer Technologies in Education (ICCTE'93) is the first conference to be held in this series in Ukraine under UNESCO/IIP aegis. It is meeting place for researchers and the emphasis is on new ideas and reflection of experiments connected to five main directions in Computer Technologies in Education:

- Educational Informational Technologies.
- Multimedia and Hypermedia Learning Environment.
- Distant Learning.
- Knowledge-based Systems in Education.
- Intelligent Tutoring Systems and their Components.

and to four application aspects:

- Student Modelling
- Simulation Environments and Teaching Science
- Teaching Languages and Humanities
- Teaching Programming.

The Program Committee includes members from 13 countries. Contribution were received from 21 countries. The proceedings volume contains 140 extended abstracts selected by the Program Committee from 160 extended abstracts submitted and classified into five directions and four application aspects mentioned above. The articles have been prepared by and (we suppose) will be of interest to:

- Researchers in artificial intelligence, cognitive science and education.
- Computer scientists and information technologists.
- Teachers and educationalists, psychologists.
- Anyone else concerned with educational innovations.

We would like to thank all the members of the Program Committee and other persons who participated in the reviewing and editing processes. The Conference is supported by several organizations. We are thankful to the following organizations:

- Glushkov Institute for Cybernetics
- International Center for Scientific and Technical Information
- International Informatics Research and Training Center IIP/UNESCO
- State Innovate Firm "INTRATECH" Inc.

Kiev
September 1993

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ASSOCIATIVE SYSTEMS IN THE INTELLIGENT TUTORING PROGRAMS

G.N. ALEKSANDROV
North-Ossetian State University, Vladikavkaz, Russia
E-mail: ipcvlad@glas.apc.org

The idea of associative system is connected with the idea of association that follows from the associative psychology, in which it is used as the main explanatory principle.

Mention that association is a connection between psychology processes (between images, sensations, notions, mental conditions, emotions, motivations, ideas).

Thus definite motion of content of association from the relation between sensations and images towards the relation between ideas and semantic formations took place.

We must especially underline P.A. Shevarev's works who introduced the idea of constants, generalizations, rules of associations, and also associations symbolically named a,b,g associations. So in these associations we speak about actualization of the connections in which second members were not only psychological processes or other actions but spheres of search with realization of analysis with the result of essential final connection.

In Samarin's works who made considerable steps in development of associative approach to mental processes the idea of forming associative systems is moved forward: local systems, particular systems, into-systems, inter-systems.

Esaulov, developing Samarin's views, considers that the main searching mechanisms are: combination, redistribution, rearrangement, self-transformation of objects.In the report he develops the author's idea that in solving problems complex associative processes take place.

The main thing of actualized association in solving problems is realizing of the task (clear or not clear, distinct or not distinct).The second is realizing associative system which is transformed as a result of constant influence of the first thing.

The associative system is the system of realized contacts which reflect in mind real contacts between objects in reality characterized by definite alphabet (any final system of different symbols), total combination of words in this alphabet and the system of admissible substitutions (wider — system of methods and rules).

The base of our psychological and pedagogical approach is a concept of associative calculus (see A.A.Markov, P.S.Novikov and their followers).

Concepts of open and closed, adjoining and meta-associative systems are introduced. Associative systems form a certain hierarchic structure in human activity. They reflect real connections of different levels (Samarin).

Human activity is considered as an activity directed to forming new words in given associative system, proving of words equivalence, making up new associative systems, their transformations according to aims.

Examples:

- While solving a question of belonging the object to definite class a student must build up meta-associative system of signs (conjunctive, disjunctive or combined) and then having the concrete associative system which characterizes the object, solve the question of its belonging to definite class.
- To prove some materialistic affirmation. First of all a student must choose the principle and way of proving. To do this he constructs associative system which contains necessary alphabet, definite words and admissible substitutions (in this case rules of logical conclusions and so on). Using this meta-associative system a student proves the words equivalence.

- The actions of a student are the same while solving any task which needs research. First of all he sets the belonging of the task to definite class. If this class is known to him a student builds up a suitable metasystem as the alphabet and words have generalized character which secures their use not only in concrete case but in any other cases. If we do sums with transformation of numbers instead of them we use general positional notes, canonical forms of numbers, different forms of transposed numbers in common case and so on. If the class is unknown a student constructs the meta-associative system in which the task is expressed in the searching of the word or proving words equivalence.

There are the results of researching experiments set up by the author.

THE IMPLEMENTATION OF EDUCATIONAL INFORMATION TECHNOLOGY ACROSS AN INSTITUTION: A CASE STUDY AT THE UNIVERSITY OF GLASGOW

KATH BAKER
Computing Service University of Glasgow
GLASGOW G12 8QQ, Scotland
E-mail: K.Baker@uk.ac.glasgow.compserv

Introduction

Using the University of Glasgow as a case study this paper seeks to examine the current status of the introduction, implementation, delivery and evaluation of Information Technology within the United Kingdom Higher Education sector. Certainly the practical use of Information Technology in education is becoming more obvious as several of the base technologies come to key points in their own development and implementation: high quality sound and graphics on even relatively low level machines, software reliability and flexibility, extensive and high quality networking allowing the transfer of images well as text, multimedia and its role in uniting other technologies. More importantly the educational theory and practice of the use of the technology is becoming established. However, many of the very obvious and encouraging successes have had a limited impact on the delivery of learning as a whole and the result is often described as a rather plain mix enlivened with cherries, rather than as the rich fruit cake that might be hoped for!

Summary

The United Kingdom has benefited from a series of centrally funded and endorsed initiatives, put in place by the Universities Funding Council and its successor bodies the funding councils for Scotland, Wales, Northern Ireland and England. These initiatives include the Computers and Teaching Initiative (CTI), the Information Technology in Teaching Initiative (ITTI) and most recently the two phases of the Teaching and Learning Technology Programme (TLTP), the Flexibility in Teaching and Learning Scheme (FTLS). The University of Glasgow has a history of successful work under these initiatives.

Against this background the University has developed and is implementing an Information Technology strategy, integrated with the full institutional strategy. These strategies call for the development of a University-wide Information Technology community, encompassing all groups and including undergraduates, postgraduates, teaching staff, researchers and support staff. The electronic and human networking that this requires and the overall management of the strategy is under the direction of the Information Technology Officer. This post has been newly created as part of the University's commitment to finding, implementing and supporting the widespread use of policies which work to encourage the satisfactory and effective integration of Information Technology in its educational endeavour.

In addition to other major Teaching and Learning Technology Programme projects the University of Glasgow is currently running the TILT project (Teaching with Independent Learning Technologies) with the aim of encouraging the use and evaluation of independent learning technologies, particularly IT-based technologies, in higher education. Its overall aims are:

- To develop methods of enhancing students' independent learning and of improving staff productivit.
- To develop methods of training students to become skilled independent handlers of information.

To develop methods of modifying teaching and learning strategies which utilise these new student skills to improve the quality of students' learning.

- To develop methods of evaluatjng this learning, based on explicit learning objectives.
- To disseminate widely the outcomes of the project.

Over twenty different groups within the University are working on five interlinked areas: numerical data, mathematically-based models, textual information, multimedia and evaluation and staff training. As with many of the projects undertaken at the University the emphasis is on general principles which can be derived and disseminated.

This, together with other experience in collaboration with external bodies and other similar institutions, means that certain principles for the successful use of Information Technology across an institution may already be suggested. These include but are not limited to:

- The need for sound educational reasoning behind the decisions taken.
- Central institutional support.
- Suitable mechanisms for encouraging debate and dissemination across the groups involved,
- The provision of general and course-specific access to relevant technology for the undergraduate population as well as for the academic staf.,
- The integration of information technology-based delivery within the curriculum.
- The provision of reliable and efficient networking and electronic communication.
- Targeted training and updating of those involved in delivery.
- Timely and effective evaluation of the both individual elements and learning overall.

The creation of a community literate in Information Technology and able to make reasoned decisions in the field of its use in education.

THE PECULIARITIES OF COMPUTER-AIDED INSTRUCTION INTELLIGENT PROGRAMS

FELIX I. BALANDIN
Computer Science Department
Nikolaev Institute of Shipbuilding
9, Geroev Stalingrada Av., Nikolaev, 327025, Ukraine

In CAI the student's individual peculiarities can not be fully taken into account at present. Nevertheless, it is possible to provide some freedom for an individuals specific development by using intelligent dedicated programs.

The following methods are used:

- The application of a simple and intelligent menu.
- The determination of a necessary place in reasoning, causing an invalid result.
- The allowance for the possibility of the application of reasoning or method for obtaining proper results.

When using a simple menu, the application of the most simple question-and-answer systems assume that an extended answer systems assume that an extended answer is called from a given list of questions. The intelligent menu enables to predict the non standard formulation of a question and the availability of the procedure of matching inquiry texts with one of standard questions from the list stored in the memory. The determination of the beginning of an error process may be accomplished by imposing patterns in LISP as the system of inserted lists.

The automation of computer procedures for the solution of special tasks is rather complicated and soluble. The application of programs for a non-professional user which enables to bill in a data base and a knowledge base may be considered most effective for various problem areas.

Computer modeling of knowledge assimilation should be based on some processes taking place in a human brain and in the structures of dynamic programs in LISP-like media. Among them there are LISP, FRL, PLANNER and others.

Of special interest there are analogies between the computer-controlled process of assimilation and the student. Self-controlled and self-developing computer systems may enable to model instruction procedures more truly.

Practically any programming language may be used to accomplish the simplest independent process in a computer by creating a continuous cycle with some conventional forms of filling up a data base. To develop and modify a data base it is necessary to have higher level languages of more complicated algorithmic structures which start operating when all necessary information in bases has been compiled and may be developed and modified during the process of the system development. It should be noted that the process of the intellect's independent development in a computer may be compared with the process of human intellect development while assimilation the given object area, and they are characteristic of some specific properties.

INTEGRATING HYPERTEXT, SIMULATION AND COMPUTER INTERFACED SYSTEMS IN TECHNOLOGY EDUCATION

MOSHE BARAK
Department of Education in Technology and Science,
Technion, Israel Institute of Technology
Technion City, Haifa 32000, ISRAEL
E-mail: TTR0125@TECHNION.BITNET

The broad use of computers for analysis, design and control of technological systems is not yet reflected in the curriculum of undergraduate technology education. Many methods used by engineers are also used for high school education.

In the following example an authoring system is used for integration of theory and practical studies on the subject of "Computerized control systems":

- A Hypertext file provides theoretical background, such as introduction to computerized control systems; block diagrams; the concept of pulse with modulation (pwm) control; principals of PID control.
- The computer is interfaced to a system for "light control", including lamps, a light sensor and an A/D converter.

- A series of Turbo Pascal programs is used to activate closed-loop control, data collection and analysis. The programs can be activated from the authoring system environment.
- The learner uses a simulation package for electronic circuits analyses, in order to examine specific parts of the electronic system, i.e., the sensor circuit.
- Sets of exercises, problems and tests guide learner's activities and provide feedback.

In this example, a professional simulation program, hypertext, I/O hardware and control software are linked by the authoring system to an integrated learning package.

Many educational technologies were tried out in the classes during the recent decades. most of them had only minor effects on the ways teachers teach and pupils learn, maybe because they were just better ways of knowledge delivery. Recent experience shows that today's technological studies (e.g., electronics or mechanics) in high school, has the potential to conduct the use of computer technologies in the classroom and enable a real interaction between students and sophisticated tools.

INTELLIGENCE IN EDUCATIONAL COMPUTING: THE IMPACT FOR UKRAINIAN INFORMATIZATION PROGRAM

VLADIMIR I. GRITSENKO, ALEXEY M. DOVGIALLO
Glushkov Institute for Cybernetics
40, Prospect Academika Glushkova
252207 Kiev, Ukraine
E-mail:dovgkiv@sovam.com

Young Ukrainian state needs rapid evolution of content and methods of public and professional education to the level of international standards. Information technologies (IT) combined in a National program must help this evolution. Here traditional goals of IT in education (computer literacy, training time reduction, guaranteed quality of instruction) are combined with additional goals such as:

- Individualization of instruction as a technique for students creative abilities development.
- Training in the cooperative skills.
- Interconnections between work, investigation and training.
- Humanitarian features in general and professional education, etc.

These goals demand high level of *intelligence* in the educational computing both in *content* and *methods* of instruction. Our general line here is to support and improve the problem solving activity of individuals and groups.

Intelligence in the *content of education* includes:

- Technological and spiritual aspects combination in a subject matter curriculum for the harmonic development of student's logical and imaginative thinking.
- The ecological literacy and national aspects in the international education are among new topics of spirituality.
- Educational modeling of subject areas.
- New kinds of cognitive activity such as:
  - Knowledge bases and expert systems creation by students for topics being studied.
  - Natural language interfaces creation for data and knowledge bases.

- • Adult learning principles (more task oriented content, knowing why students are being taught some content, participation in the control over learning, etc.) are valid not for adults only.

An intelligence in methods of instruction includes:

- Adaptive computer-assisted testing and instruction.
- Participation in and creation of educational games (computer and video-computer based).
- Distant cooperative problem solving of students and teachers.

To implement above mentioned features of intelligence in the variety of curricula it is necessary to develop special techniques and tools and to organize teacher's training in these techniques and tools. Glushkov Institute of Cybernetics and Scientific Training Center of UNESCO/IIP disposes a set of intelligent educational modular tools:

- BESS and BETS — educational expert system shells.
- KEY — the tool for natural language information systems creation.
- PALEVAS — macros for adaptive CAI etc.

Now these and some other kits are being combined with well known tools in a technological line (D-line) for educational knowledge structuring and refinement. This line helps a teacher or a knowledge engineer to transform rapidly source educational materials (texts, pictures, sound, video sequences) to electronic books, testing and CAI systems, educational data and knowledge bases. Due to the presence on the D-line entrance of common initial material all these educational software topics are connected among themselves and easily can may be used for the creation of rich learning/teaching environments.

These results and ideas are combined in the Ukrainian-Azerbaijan project "Computer-Based Didactic Lab: an information environment for teachers" submitted to UNESCO/IIP. The general goal of the project is to create a special information environment for didactic problem solving and continuous teachers training in educational IT and AI. The Computer-Based Didactic Lab must support teachers participation in new courseware creation for their own curricula. Some modules of the teachers training course were successfully tested on the Ukraine, Azerbaijan, Kazakhstan, Cuba, India and Syria.

A POSTMODERN THEORY BASE FOR NEW INFORMATION TECHNOLOGIES

DENIS HLYNKA
Faculty of Education University of Manitoba
Winnipeg, Canada R3T 4A6
E-mail: dhlynka@ccu.umanitoba.ca

Keywords: philosophy, postmodernism, information technology

1. Education (pedagogy) is both art and science. When we consider education to be grounded in science, it is appropriate to use the techniques and methodologies of the sciences. EDUCATIONAL TECHNOLOGY has become stuck within this positivist scientific paradigm which limits opportunity for scholarly inquiry.

2. Education is also an art, not a fine art, but a practical art. This implies that there is another paradigm by which one can fruitfully explore the nature of technology and its relationship to education. When educational technology is perceived as art, it would appear that we should use the

methodologies of artists, of art critics and of literary theorists. These techniques include, but are not limited to postmodernism, deconstruction, semiotic analyses, and educational criticism/connoisseurship.

3. This paper will outline the paradigm shift which allows us to examine educational technology through a postmodern lens.

4. *Postmodernism* is a term which attempts to describe the condition of contemporary society coming to grips with the failings of modernity. It is a concept of particular relevance as we approach the 21st century. Postmodernism implies "incredulity towards metanarratives", "disorienting reversals", and an acceptance of pluralism in thought, culture and language. Postmodernism occurs at the intersection of "constructed realities". The result is ironic confrontation of alternative paradigms.

5. It is important to point out that postmodernism is not an ideology. It seeks no converts. You cannot choose to be postmodernist. Postmodernism is a condition. It is a condition of the contemporary world.

6. The following binary distinctions separate traditional educational technology from postmodern educational technology. The first word in each opposition represents the normal view; while the second represents a postmodern questioning:

- Value neutral / value laden.
- Objective / subjective.
- Science / art.
- Technology / nature.
- Context free / context dependent.
- Linear / fragmented.
- Single-voiced / multi-voiced.
- Technical / critical.
- Progress / simultaneity.
- "One best way / multiple ways.
- Permanent / fleeting.
- Quantitative / qualitative.
- Technological / humanistic.

7. Deconstruction would point out that the first of each combination of terms is the one which is valorized or assumed true. Deconstruction would then attempt to switch the valorization and show how technology is best represented by the second set of oppositions.

8. Traditionally, educational technology has explored the implications of the new media from the standpoint of a systematic define-develop-evaluate model. Postmodernism suggests that such a model should not be abandoned, but rather placed in context with an aesthetic alternative which allows a personal response to technological potential.

9. There is sometimes a misunderstanding of the postmodern condition. Critics of postmodernism argue that through deconstruction, a chaotic and nihilistic world view is achieved. If everything can be deconstructed, this would seem to be a negative and hopeless view of the future. Postmodernism seems to be chaotic and contradictory and takes pleasure in irony and confusion. Other critics argue that if every voice is of equal value, then no voice is of any value. However, such is NOT the intent of postmodernism. The world IS multivocal: there is no one "best" language. The world IS multi-ethical: There is no one best religion which fits all.

The world *is* multi-cultural: No one culture should be dominant or best for all.

10. The question is whether educational technology can assist to reconcile the paradox of progress with multiple values. Is technology part of the problem or part of the solution? We need to believe that unity through diversity and unity through tolerance is a goal sought after by all just societies.

11. It is appropriate that this conference is held in the ancient city of Kiev, Ukraine in 1993 because surely Ukraine is the quintessential postmodern country, a country trying to come to grips with divergent values, a re-discovery of its past, a critical examination of the strengths and flaws of modernity, and a hope for the future. A postmodern educational technology is necessary as a philosophic base for a careful, systemic and critical examination of our global village.

12. Ukrainian philosopher Hryhory Skovoroda (1722-1794) has captured the paradox of the nature/technology opposition where nature in a Derridian sense requires supplementation, but not domination. It is appropriate to close with the insight of Skovoroda, still appropriate some two hundred years after his death:

"Nature is the true teacher. You can teach a falcon to fly, but you cannot teach a turtle to fly; you can teach an eagle to play in the sun, but not an owl. You do not need to teach an apple tree to bear apples: nature has taught that already. You only need protect the tree from pigs by putting a fence around it; you need to prune the tree, and spray it at the proper time. Don't interfere with nature, but if you can, smooth the path for unhampered development and keep it clear."

THE TRAINING SYSTEM OF USING THE DIFFERENT MEANS UNITED BY THE TECHNOLOGICAL LINE

TATIANA N. KAMENEVA
Glushkoo Institute for Cybernetics Ukranian Academy of Sciences
40, Prospect Akademika Glishkova, 252207 Kiev, Ukraine

In the Institute for Cybernetics the new instrumental complex of training technological modules, uniting different training means for working over the learning material into instructional systems of different pedagogical purposes is worked out.

This complex is called Technological Line.

The Technological Line consists of

- Module of the learning hypertext creation from the initial material (text, drawing, video).
- Module of the training systems development on the base of Data Base Systems with automatic construction of knowledge control questions.
- Module of preparation of expert systems.

The Training System on the means of the Technological Line represents the totality of instructions, methodological recommendations, examples of application of software and hardware.

The purpose of creation such a system is to provide simple and visual access to the information about all blocks (tools) of Technological Line and to give the opportunity of approbation of knowledge by the way of working with this or that tool.

The work with the system is organized as following.

The system gives the material to the user by the scheme presented the Technological Line (figure 1) and the menu of objects which are means and tools using for receiving and transformation learning dates into the different formats:

- Text, drawing, video.

- Hypertext.
- Control knowledge libraries, including the inquiry in natural language.
- Expert systems.

The enumerated formats are the objects of the menu and the objects of the learning process. There are two options of system-user interaction:

- Control option.
- Training option.

The user choosing the object which he is interesting in can be limited by the first option if he wants to receive the tools instruction for user in hypertext. Or if the user is interesting in the deeper knowledge on the tool he may come into the system and use it in his work.

Such work promotes the user's learning activity, increases the degree of his individuality in the learning process. The user himself chooses the object of learning and controls his mastering. Such work is very effective for unprofessional users.

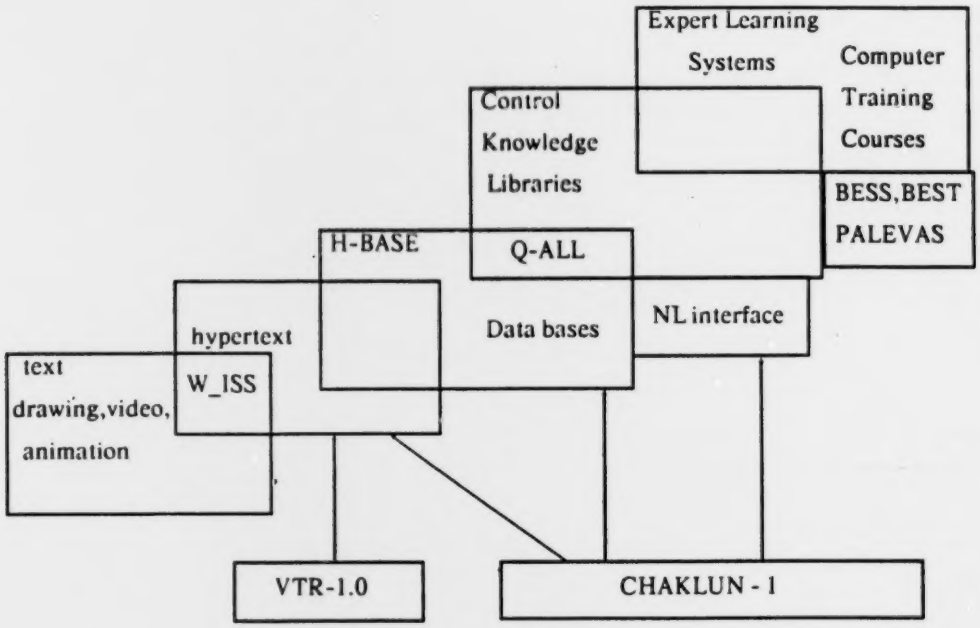

Figure 1. The Technological Line.

CREATING AND USING COMPUTER TECHNOLOGIES OF LEARNING AT LVIV UNIVERSITY

IVAN KULCHITSKI
LvivStateUniversity
1, Universytetska Str.
290602 Lviv, Ukraine
E-mail:kulchitk%lsu.lviv.ua@relay.ussr.eu.net

Keywords: Hypermedia, Multimedia, Computer Learning Systems, Computer for Education.

This project is the result of work of a team of teachers and programmers on creating and adopting computer learning aids (CLA). The use of these aids is illustrated on the example of concrete program development.

At Lviv university the major work on the CLA development and adopting is carried out on the basis of the laboratory for the computerization of the teaching process which was founded in 1985.

The samples of programs for all the courses taught at the university are available at the laboratory and provide the opportunity for teachers to see the capabilities of CLA in their specific course. Such a demonstration allows teachers to successfully overcome their psychological barrier in the work with computers.

On the next stage an expert on computer technologies of study together with the teacher develops a concept scheme of the CLA. The scheme includes: the information about the authors of programs, the subject, the aim, for what students was the program developed, methods of learning, the expected level of knowledge of the students, program structure, special effects, supplementary materials, elements of psychological support and evaluation criteria of the programs. Further work consists in filling the conceptual scheme with specific learning aid materials.

To support the above-mentioned technologies we developed a number of tool systems. These tools automate the process of developing all kinds of CLA: information and teaching demonstration, test and training and other aids. Simple CLAs may be developed by teachers with the help of these tools.

The developer of the CLA can divide the academic scheme of work into separate parts with the help of different computer language commands. Between these separate units arbitrary links can be set. For the presentation of academic material a large number of Hyper- and Multimedia tools is added to CLA.

Special attention is paid to the automation of training exercise realization. For this purpose more than 10 types of doing the exercises are suggested.

In the process of CLA creating for new courses there appears, as a rule, a need for new algorithms for doing the exercises, which results in the enlargement of the set of types.

The developed CLA can be used in different modes: a student has a wide choice; he can study concrete topics; concrete criteria are assigned for the execution of exercises; the access to particular units of CLA is limited.

Such a CLA gives the teacher the opportunity to organize the process of using the programs for specific groups of student. In practice this means that the teacher can essentially influence the process of executing the programs.

On the basis of the created tool systems, computer learning aids for Ukrainian and other foreign languages, mathematics and other subjects are realized.

The laboratory of computerization of teaching process offers to users:

- Tool system for the creation or development of teaching programs, demonstration film for program products.

- Teaching programs for Ukrainian language study (for English, Russian and Ukrainian speaking users).
- Systems for detecting lexical and structural mistakes in Ukrainian texts.
- Teaching program for numerical methods on the topic "Interpolation of Functions". The program besides theoretical learning of the methods, makes possible the practical usage of concrete methods of interpolation.
- Teaching program on the topic: "Open Sets of Topological Space and Inside Points" with the elements of game.
- Subsystem for the study of the R-technology of programming.

MUDDLING THROUGH - THE BRITISH TRADITION! 'THE DEVELOPMENT OF COMPUTER HARDWARE AND SOFTWARE USE IN BRITISH EDUCATION.'

NORA LUCKE
Harlow College, The High, Harlow, Essex, England
E-mail: N.J.Lucke@open.ac.uk

This paper looks, from a practical viewpoint, at the kinds of hardware and software currently in use in British schools and at the ways in which they are being used.

The paper begins by looking at the latest statistics for the types of computers currently in use, and the reasons schools have for choosing, and continuing to work with such machines.

The reasons touched on include limitations in government policy in funding hardware acquisition while making limited provision for teacher training in the use of the machines, the lack of guidance given as to how the machines were to be used, and the initial lack of software. All these combined to produce the reign of the 'hobbyist' computer teacher in some British schools, and the strange attitude in others that the pupils themselves should be left to teach one another and even the teachers about computers, since the pupils were so quick to pick it up!

Many of these attitudes reflect the fact that untrained teachers were given computers and left to their own devices, with no indication at first of how the computers might, or should be used. Teachers and pupils alike had little idea what to do with the computers, and the initial result was a generation of pupils who taught themselves to program in BASIC 'spaghetti-style', while a few teachers who had little or no knowledge of computers felt obliged to introduce their classes to a variety of 'educational games' which were seen as a way of generally enlivening lessons and of providing pupils with a welcome change from a textbook. Since the software was being provided by programmers who had very little idea of what teachers wanted, for teachers had little idea of what computers could do, and therefore no idea of what to ask for, good software was slow in coming.

From this muddle, an enormous amount of innovative software was in fact developed. This paper discusses some of the main categories into which so-called 'educational software' falls, and looks at the different ways in which computers are now being used in both primary and secondary schools and in Further Education Colleges.

These categories are:

- The 'drill and practice type' (of which a distressingly large number are still on sale and are apparently selling well).
- The 'moving textbook' type, which exploits the computer's ability to draw and modify pictures and/or diagrams in response to input.

- The 'resource type' which encourages the pupil to use the computer as one of several 'resources' (some of which are also supplied by the producer of the software) to use in the preparation of some project.
- The 'database type', in which the pupils have access to a large database which can be used in a variety of different ways, some of which overlap between pure 'database type' and the 'resource' type. The 'database' category includes dial-up access central databases and those supplied to schools on CD ROM.
- The 'LOGO type', which attempts to teach sometimes very young pupils techniques of problem solving by modular design.
- 'Office type' applications programs.

All of these types are illustrated by reference to numbers of different programs currently on sale in Britain.

The paper concludes with a very brief reference to the future of computers in British schools and colleges in the light of the National Curriculum and the continuing problem of funding for new hardware and teacher training.

LAWS OF LEARNING AS THE COMPUTER BASED TEACHING PROBLEM

ALEXANDER V. MOGILYOV
Voronezh State Teacher Training Institute
Computer Science Department
86, Lenina Str., Voronezh, 394043, Russia
E-mail:aspo%vgpi.voronezh.su@techno.fuug.fi

Keywords: intelligent tutoring systems, student simulation, laws of learning, didactics.

One of the reasons the recent efforts in the intelligent systems based teaching do not lead to the significant success is the absence of the fundamental approach to the learning that would be based on the cause - consequence bond. Such approach requires the knowledge of the laws of learning. These laws describe the bond between of the causes and the consequences in the learning process.

Since the beginning of XIX the most famous teachers and educationists try to form the fundamental regularities of learning but there is no any consent in their views yet. So the nature of the laws of learning is described as theoretical or empirical and as non-strict or statistical. The laws are understood as the regularities binding the phenomena or the set of rules of the teacher activity. The great attention to the laws of learning problem the russian educationists paid.

The laws of learning applications to the computer based teaching and to the intelligent tutoring systems especially take a great importance as the basis of the student simulation. The set of the laws could contain as well some of the proposals of the educationists slassics and the statements of the classical psychological theories of learning as the new statements of the theoretical level of the understanding of the learning process. The set of the laws of the learning I propose is as follows:

- The law of the interiorization that means the externality is transferred to the interiority. It is very common law of learning. It is contained in the concrete mechanism by the theory of Galperin and Talizina.
- The law of the associative relatedness of knowledge that lays in the basis of the associative theory of learning.
- The law of copying of the cognitive patterns of the source in the learning.

- The law of the motivating confirmation that contains the basic idea of the so-called behaviourizm.

The set of laws of learning is the basis of the teaching systems design and students simulation in the intelligent tutoring systems. The contents and application of the laws is disclosed in the report.

PEDAGOGY WITH HYPERMEDIA

JURY MOHYLA
Faculty of Education, Humanities, Law & Theology
The Flinders University of South Australia
GPO Box 2100, Adelaide, S.A. 5001 AUSTRALIA
E-mail: edjm@cc.flinders.edu.au

Keywords: pedagogy, curriculum, multimedia, hypermedia, cognitive psychology

Pedagogy, the art and practice of teaching, is once more receiving well deserved attention. In the process of preparation and education of teachers it becomes evident that the effective use of technology can dramatically improve the learning experience for new teachers as well as their future students. The old adage still holds: teachers teach as they were taught.

Computer technology is revolutionizing practically every facet of society. The computer in education is neither instruction nor method of instruction; it is a powerful pedagogical tool that needs to be considered whenever theories of learning and curriculum development are discussed.

This paper will discuss the application of non-computerised multimedia, multimedia and Hypermedia to preservice and inservice teacher education.

INTRODUCTION

A community that gives high priority to the care of its young and its aged, is a community that has insured its own survival in the future. Equality of opportunity at every level of education from pre-school to postgraduate studies in university becomes the cornerstone of an information rich society.

At times when the demand for education is increasing, and the educational resources, both in personnel and material sense, are critically low, new innovative curriculum reform has to take place. In Australia, the average age of teachers is ten years higher than it was two decades ago. The number of gifted teachers is and has always been smaller than required. However, the demand for quality education from Australian and International students is high.

Teachers have long been enhancing their presentation by radio, television, films, slides, recordings of music and voice. They were teaching with audio-visual aids, and the students' learning experience was also enhanced. Despite the advantages of audio-visual presentation, the learner remains a passive receptacle of information and knowledge. This soon changed with the advent of the computer. At first it was the university students who had access to the mainframes and later the minicomputers for interactive learning. Limited as it may be, the learner had control of the process. Using the computer to acquire and assimilate basic skills or to model and simulate real events and physical systems the student had access to a powerful learning medium. The introduction of the personal computer expanded the accessibility of this learning medium to all levels of education.

Computer Assisted Learning (CAL), Computer Enhanced Learning (CEL) and other acronyms followed. In every case the computer provided the learner with increased control and greater opportunities for exploration of new knowledge and skills.

Interactive Video (IV) when combined with the computer assisted learning techniques offers another information system that has been supported more by the training than the education environment. A classroom that still has lessons, and in the higher education people call it lectures, can now be supplemented by computer controlled audio-visual material that contains videodisc images as well as the projected contents of the computer screen.

TEACHING WITH MULTIMEDIA

When a computer is used to combine and control multiple media such as numerical values and text, sound, graphics, scanned images, animation and full motion video, such combination becomes a multimedia system. Multimedia offers teachers and students a collaborative educational environment in which communication between teacher and student is highly enhanced. It allows the learning process change in response to new circumstances. In addition, interactive multimedia offers a far more effective way of communicating dynamic processes that change rapidly over time or space.

Multimedia is technology not pedagogy. Only when it is incorporated in the teaching/learning process does it become a powerful agent in education. It holds a promise of improving education. To realise this promise a change in the methods, attitude and nature of curriculum across the full range of education has to take place. At the same time there is a need for evaluation of the effectiveness of this type of learning environment.

At Flinders University, undergraduate as well as graduate students in the School of Education have been and are offered courses in Educational Technology. The emphasis is changing from audio-visual multiple media to interactive multimedia. To re-enforce the program, teaching methods and student learning reflect some of the current trends in information technology. Other courses in other Faculties and Schools within the university have also been, either leaders in, or developers of, instructional information technology material.

Multimedia materials are designed to stimulate the maximum number of senses in the learner. Depending on the age of the learner and content, an appropriate application of a number of learning theories would form the backbone of multimedia courseware. The learning experience would be heightened in the following ways.

- Increased stimulation.
- Greater motivation.
- Higher intellectual content.
- Deeper understanding of subject.
- Student directed learning.
- Broader application of knowledge.

TEACHING WITH HYPERMEDIA

Hypermedia may be seen as an extension of hypertext to multimedia. The difference between a hypermedia system and hypermedia can be compared to the difference between a database management system (software) and a database (the information base).The works of Ted Nelson (1967) and Douglas Engelbart (1968) on hypertext define three main features: a set of nodes, a network of links interconnecting the nodes, and a hypermedia system. The nodes are the containers of information in multimedia form and the links interconnect the nodes so that the information can be accessed in a structured or unstructured "brainstorming" sequence of events. There are two components within the hypermedia system: the "author" and the "browser". A number of hypermedia systems are available, such as HyperCard and IBM Linkway. All of them implement in one form or another the facilities of the "author" that allows the creation and editing of the contents in the nodes, the nodes and the links and the "browser" that provides the facility for accessing

information in hypermedia. We are currently developing material in hypermedia on a number of platforms.

TELETEACHING AND COLLABORATION TECHNOLOGY

Collaborative technology is defined as a set of tools, techniques, theories, multimedia communication and logistics aimed at enhancing the ability of people to work together, particularly when they are separated by large distances and time zones (LINKS, 1990). Tools and theories for collaboration technologies focus on group work.

In 1992 a proposal for the establishment of an Advanced Engineering Centre for Information Technology and Telecommunications (AEC) was lodged with the Department of Employment Education and Training (DEET). The AEC is a joint venture between University of Adelaide, the University of South Australia, the Flinders University of South Australia, and the South Australian Department of Technical and Further Education and Training.

It is intended that students of the AEC will, as part of their every day educational experience, use the information and telecommunication technologies which will form the basis of their professional careers in industry. The dispersed student body will therefore take many programs using advanced telelecturing facilities. Students will also be provided with comprehensive computer workstations and communication facilities (AEC, 1993).

It is also intended that the teleteaching facilities of the AEC be made available to other users from within participating Institutions and from other organisations.

This discussion will outline the five principal activities that need to be supported by the teleteaching facilities.

- Telelecturing.
- Teletutorials.
- Telemeetings.
- Networked Computer-Aided Instruction.
- External Collaboration.

CONCLUSION

In the preface to the book on *Some Aspects of University Education Overseas* published in 1963, M.L. Oliphant, from the Research School of Physical Sciences: The Australian National University: Canberra, A.C.T: now (Sir) Mark Oliphant said: "Education will become what it should be, a unified activity of all mankind, where nations and races will share their cultures, their technologies and their geographies, through interchange of this educational material."

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THE FRAMEWORK OF THE PEDAGOGICAL INFORMATICS

E.N. PASKHIN
The Russian academy of administration Moscow
84, pr. Vernadskogo, Moscow, 117606, Russia
E-mail: ksm@raa.msk.su

Keywords: pedagogical informatics, informatization, life-long education, education, computer training

The technological revolution of our days brought about mainly by computer technologies, is now transforming all the intellectual activities, including the area of education. The modern computers form a basis for the processes of informatization in the educational field. And these processes are characteristic for all stages of the life-long education in our country - beginning from the school and the college up to the systems of professional training and re-training. That is why the informatization in education has a systemic character and meds a solid scientific base. And this is the task of new scientific branch - the pedagogical informatics.

Scientific research in the field of informatization in education may be deviated into several directions. First, there are studies of the various problems concerning scientific and methodological base of a new curriculum course, which is "The basic of informatics and computer technologies". Second, we have studies of the problems concerning the sphere of computer usage in other courses. The third direction treats problems of psychological and pedagogical aspects of the computer training as well as modern methods and forms of training on the base of new information technologies (NIT). Next direction is methodology and programming for local computer networks at the institutes of higher education. At last, we have also problems of the social character in the field of computer education. Because of the systemic nature of all these problems we face the task of involving specialists from different branches of science and education. And best results will be achieved, if the scientific research in the field are conducted in the framework of a new scientific branch - the pedagogical informatics.

The pedagogical informatics may be defined as a scientific field concerning various informatics aspects of educational activities as well as appropriate methods of teaching and technologies of information handling and automatization. All those should be directed towards perfection of the pedagogical processes, this individualization and optimization. in general the pedagogical informatics should have as its subject the interactions between education and informatics, to study various aspects and trends of this interaction. The pedagogical informatics comes into being at the crossroads between informatics and a number of pedagogical disciplines; it has its peculiar concepts, terminology, aims and methods. Among its priority problems there are methodological problems of informatization in education, development and practical use of the new information technologic for educational tasks; psychological and pedagogical aspects of computer training, methods and forms of training on the basic of computer technologies, social aspects of informatization in education and some other. There are some regular trends and tasks peculiar to the pedagogical informatics. First, there is a necessity to computerize the process of educational training as first step to the informatization of education in the whole. Second, important to secure priority of the pedagogical methods of the training in comparison with the technical means. Third, we see the growing importance of the algorithmic knowledge and algorithmic style of the thought. Forth, there is a steady growth of the general information culture of the society, and this trend also should be reflected in the pedagogical informatics. And, at last, there is a principle of a life-long education on the basis of information and computer technologies, including telematic technologies.

RECONSTRUCTIONISM - THE NEW BRANCH OF CONSTRUCTIONISM?

EVGENY D. PATARAKIN, LARISA L. TRAVINA
Program Systems Institute
Botyk, Pereslavl-Zalessky, 152140, Russia
E-mail: jenja@mdkc.botyk.jaroslavl.su

Keywords: cognitive models, hypermedia, logo-like environment.

Constructionism as a philosophy of education looks for better things to do and more powerful ways to think about what are you doing. This word expresses the idea that knowledge is build by the learner especially felicitously when the learner is engaged in the construction of something external or at least shareable a sand castle, a machine, a computer program a book (1) (Scheme 1).

Objects	Construction	Ended product
Student	The construction of knowledge	(book, map, animated cartoon)

Scheme 1. Constructive education.

In the process of constructive education the child has work as inventor and reinvent the explicit knowledge. We believe that new branch of constructionism can be based on the reconstruction of the implicit child's theories (Scheme 2).

Mind	Reconstruction	Ended product
Student	The reconstruction of knowledge	(implicit cognitive models)

Scheme 2. Reconstructive education.

Theoretical background of our work was the Kelly theory of personal constructs. From the Kelly's point of view, a man has explored his environment in all periods of his life. In any moment he/she has build hypotheses about environment and lives on the base of these hypotheses. Intervention of Kelly's ideas to the computer media seems very promising for us. We made a special LogoWriter Version of Repertoire Greed Test (RGT), proceed from this. An ended product is a specific computers constructor. With the help of this constructor students can create a computer map of their inner world. In the process of education students categorized elements and discussed with teacher different computer models of a their cognitive structure. We have successfully used this tool in various educational projects, and we believe that it successfully support new mixed educational environment (Scheme 3). Within the framework of this environment students have actively made various hypermedia creative products.

Objects	Construction	Mixed ended product
Student		
Mind	Reconstruction	

Scheme 3. "Mixed media".

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REUSABILITY SERVICES IN THE COURSEWARE AUTHORING PROCESS

DONATELLA PERSICO, LUIGI SARTI
Istituto per le Tecnologie Didattiche
Consiglio Nazionale delle Ricerche
Via all'Opera Pia, 11 16145 GENOVA, ITALY
E-mail: sarti@itd.itd.ge.cnr.it

Keywords: courseware production, courseware reuse, intelligent authoring systems, multimedia databases of learning material.

The issue of reusing software artifacts, in the aim of fostering the process of building large software bases, limiting their cost and improving their reliability is an extensively debated topic in software engineering.

On the other hand, courseware reuse is almost a brand new field: few researchers have explored methods, techniques and tools devoted to the improvement of the various phases of courseware authoring.

One possible way of tackling this problem is to approach reuse as it has been developed in software engineering, to sort out those techniques and methods eligible to be applied to the more restricted - and in many ways different - field of courseware development. Some of the considerations reported in this document are based on software reuse methodologies; in particular, Krueger's accurate and thorough survey on this topic [Krueger 92] has been used as an effective source of ideas. In addition, the literature in the field of information retrieval systems provides plenty of hints on how to support retrievability of courseware artifacts from a database of learning material.

What is courseware reuse?

Courseware reuse is the process of integrating some existing courseware components into a new teaching/learning system rather than creating it all from scratch. Such a definition refers both to the reuse of multimedia learning material (i.e. pieces of text, sound, graphics), and to any half-product of the courseware design phases, such as for instance domain representation, learner model, etc.

In this paper, we make the assumption that the following equation holds: reusability = retrievability + adaptability.

Making the material easily accessible to the author is a first necessary condition to achieve reusability. Retrievability can be improved by designing and developing a pool of material, endowed with querying functions specifically tailored to suit authors' needs. To this purpose, the material should be decomposed into self consistent units and endowed with a suitable characterisation (the so called indexing).

There is no point in being able to retrieve useful material if its integration in the new context is so painful that is not worthwhile. There are many practical issues to be tackled in order to achieve adaptability: copyright problems to be solved, hardware and software dependencies to be overcome, cultural biases to be removed, references to the original context to be changed. Besides approaching these problems from a purely pragmatic point of view, by providing conversion tools or automatic translators and similar support functionalities, it is possible to promote a culture of courseware adaptability, by proposing guidelines and approaches to the design of reusable material that facilitate its subsequent employment in different contexts. In other words, in analogy with the software engineering field, reusability is easier if the material has been designed to be reused. How to define the features and development methods that make material more easily reused is the focus of the following paragraphs.

Why courseware reuse?

Courseware reusability is being investigated in the hope that the availability and modifiability of large pools of courseware can heavily reduce the development costs. This holds in particular for the costs of production of high quality multimedia learning material, that in fact requires the

employment of several kinds of expertise, involving graphic designers, actors, directors, film makers (if it includes video) and programming competence, knowledge domain and instructional expertise. The development of instructional audio-visual programs cannot, in fact, be improvised, and it is a very expensive enterprise. For example, an author can extract useful sequences from existing ones, add a different audio, and integrate them with other material developed from scratch or coming from other sources. In conclusion, for reuse to be a real value, the artifacts to be reused are not necessarily suitable for the purpose since the very beginning; nevertheless, they must be easily modifiable, otherwise the costs of reuse can be higher than the costs of development from scratch. This point is particularly interesting for enterprises that produce training material for different contexts but, usually, with similar training approaches and on similar domains.

What features for courseware reusability?

All approaches to courseware reuse share the need for the following features:

- Selection: an author has to select, amongst a set of possibly reusable components, the one which best suits his/her needs. The flexibility of an approach based on database techniques can provide the author with a valuable aid in indexing and retrieving existing artifacts.
- Abstraction: this is the essential characteristic of any approach to reuse, as it allows the author to quickly understand the features of a reusable component without the need of examining the details of its structure and implementation. Cognitive distance is the amount of intellectual effort required to an author to understand the features of a given reusable artifact: the better is the abstract representation of the component, the less is the effort from the author.
- Specialisation: once a component has been identified and selected, it must often be adapted to the new context of usage; the more generic is the original artifact, the wider is its range of reusability, through a proper refinement activity; it is nonetheless important to consider the cost of such specialisation.
- Integration: a reusable component is a module offering some services, endowed with a specific interface; the integration activity consists in implementing the protocol that controls the component, interacting with it through its interface. With software components, interfaces are formally defined, thus allowing for the implementation of reliable protocols; in the case of courseware it is often impossible to provide a formal definition of the resources required by a reusable artifact, therefore calling for the author's explicit intervention in the integration activity.

The rest of the paper describes some proposals to enhance reusability by supporting the author of courseware with the features listed above.

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DIGITAL VIDEO IN A PC ENVIRONMENT

PHILIP BARKER, ASHOK BANERJI, CHARLES LAMONT & STEPHEN RICHARDS
Interactive Systems Research Group, Human-Computer Interaction Laboratory,
School of Computing and Mathematics,
University of Teesside, Cleveland, UK
E-mail: Philip.Barker@uk.ac.Teesside

Keywords: digital video, multimedia, hypermedia

The advent of the multimedia personal computer (PC) has meant that many new approaches to instructional delivery can be created. Of significant importance in this context is the availability of high quality sound, photo-realistic images and motion video. These resources can be combined, where appropriate with supporting textual material, in order to create many different types of interactive learning environment based upon both linear and non-linear approaches to information delivery.

In the work that we have been recently undertaking we have been concerned with various approaches to the provision of digital motion video in a PC environment. Motion video has been employed for the support of computer-assisted learning and computer-based training using an electronic book metaphor. The type of electronic book that we have been developing is referred to as a 'moving picture book'. However, other types of multimedia and hypermedia book (that embed motion video segments) have also been created to support a range of different automated teaching projects involving the design of electronic performance support systems (Barker and Banerji, 1993) and the development of interactive learning environments to support the teaching of foreign languages (Barker, Giller, Richards, Banerji and Emery, 1993).

A number of different approaches to the provision of digital motion video have been explored. Our early work was based upon the use of analogue video disc for the storage of TV quality motion video pictures. As well as storing video, such discs can also store any accompanying sound effects and/or audio narrations in analogue form for direct playback with the visual material. Unfortunately, there are many problems associated with using this approach to audio-visual provision-particularly, when it is required to perform 'voice-over' with 'freeze-frame'. In order to overcome these problems we have used a 'hybrid' approach based upon the use of video disc for picture storage and compact disc (CD) for the storage of audio material in digital form.

In our early systems (described above) the analogue video material retrieved from optical discs was digitised in real- time as it was brought off the disc and then displayed directly on the computer's CRT monitor. The control software for this system allows access to individual frames on the video disc. Images and video clips could also be displayed on the screen within windows that could range in size from a 'postage stamp' through to full-screen.

The above system has recently been extended to include digital compression and decompression facilities so that incoming material from a video disc (or other analogue source) can be digitised, compressed and then stored digitally on a hard-disc (or a fast-access CD drive). Once the material has been stored it can be retrieved, decompressed and then displayed on the CRT screen of the host workstation.

Our other approach to the provision of motion video in a PC environment is based upon the use of Intel's digital video interactive (DVI) technology. The most recent DVI board-set that is provided by Intel allows two basic functions: video capture from a range of different analogue sources (based upon digitisation and compression); and delivery (using real- time decompression techniques). Two basic workstations based upon this board-set have been constructed and are now in routine operational use. One of these (the authoring station) is used for creating video-based training resources and the other is used for their delivery. While the authoring station needs to embed both the compression and decompression units, the delivery stations need only be equipped with the decompression facility. The storage requirements for motion video using this approach is approximately 10 megabytes per minute. We have stored digital motion video on conventional CD and delivered from this medium in a number of different training applications.

Our latest work with motion video has been conducted with decompression software (Microsoft's 'Video for Windows') which can be used even without the need for any additional boards within the delivery PC. The quality of video presentation using this approach depends upon a number of factors - such as processor speed, window size, screen resolution, and so on. The quality of the video can be enhanced if various sorts of 'hardware assist' facility are available within the host PC.

Within our laboratory, digital motion video is being used increasingly within hypermedia training resources. For this reason we have been exploring the problems of incorporating hotspots (reactive areas) within digital motion video sequences. Two approaches are currently being explored. One is based upon the use of 'key frame' sequences while the other is based on 'persistent object' tracking. Each of these approaches requires the provision of appropriate author support tools (to facilitate hotspot creation and linking) and end-user interface facilities (to facilitate interaction and navigation). Currently, these two approaches are being compared so that the most appropriate and useful hotspot mechanism can be adopted.

In the full paper a description will be given of the use of motion video in both linear and hypermedia instructional software. A number of case studies will be described and some results of controlled evaluation experiments will be presented.

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THE SCHOLAR'S DESKTOP: A UNIVERSAL LEARNING SUPPORT ENVIRONMENT

T.J. BRAILSFORD; S.C. SCARBOROUGH; P.M.C. DAVIES & B.M. HURST
Bio-informatics Research Group, Department of Life Science
University of Nottingham, UK
E-mail: TIM_BRAILSFORD@UK.AC.NOTTINGHAM.VME

Keywords: CBL, hypermedia, knowledge elicitation, learning support environment, authoring shell.

One of the major problems with Computer Based Learning is that the amount of time and effort that needs to be put into developing even simple courseware is huge. Professional CBT companies frequently quote development time of more that 300 man-hours per hour of courseware. If CBL is going to become important in academia then this figure must be substantially reduced. One strategy by which this is likely to be achieved is by the use of standard "shells" to which an author adds the subject material. In this paper we will discuss the issues involved in designing such a shell and describe our "Scholar's Desktop", which is a learning support environment that has been developed to deliver undergraduate courseware on both Macintosh and Windows platforms in a consortium of 42 British university biology departments.

This approach to CBL had its origins in the IBiS (Interactive Biological Information System) software developed for the "Images of Life" videodisk that we produced in 1987. This uses a BBC B+ fitted with a genlock video overlay board and although this is now obsolete technology, it formed the design platform for many of our subsequent developments. Subject specialists developed courseware by providing captions and storyboards that utilised the available resources, and they specified

graphic overlays and hot-spots. The system consists of several interlinked browsing hierarchies. At each point (or node) on the hierarchy the user may look up information or review the images associated with it. Any given image might appear at more than one node (eg a photograph of a lion could appear at nodes about mammals, carnivores or savannah dwellers), and there are also likely to be links to other images on the disk. These links include "Change Appearance" (different views of the same object), "Change Magnification" (different images of the same object at differing magnifications), and "Change Biolevel" (different levels in the hierarchy of biological organisation, ranging from molecules to communities and beyond).

The data structure required for this was highly complex, with a single node consisting of many files in a number of directories. A suite of editing software was thus written to facilitate entry of this data in the required format. However this software required extensive training in order to use it effectively and it was considered undesirable to require this of subject specialists. They thus submitted paper versions of their nodes on standard forms, and the development team keyed these into the editing suite. This was necessarily an iterative process that proved to be extremely expensive in the development team's time. It did however prove to be a highly effective means of getting useful material from subject specialists who had minimal technical knowledge and neither the time nor desire to become programmers.

The "Scholar's Desktop" provides for the flexible delivery of multimedia courseware that embodies a wide range of learning styles. This will consist of a large number of small study units, each designed to occupy an average student for 30-40 minutes. The content of these will in most cases be prepared by a team of authors from several institutions (it is anticipated that this will circumvent the "not-invented-here" syndrome that has in the past inhibited the widespread use of CBL in British universities). Each study unit consists of several semi-autonomous nodes of information - each of which consists of one or more pages of media from the resourcebase. Resources (ie text, graphics, sound, video, etc.) are stored as data files outside of the main delivery engine. This facilitates the portability of the courseware between hardware platforms, and makes it easy for local teachers to effect quite substantial modifications to the subject material should they so desire.

Each node is fronted by a single primary page, which can consist of a succinct piece of text, an image or the start of a simulation. Each primary page is supported by a "spiders-web" of secondary pages that appear in popup windows. These can be accessed in any order by clicking on textual buttons or hot-spots on graphics. Secondary pages are used for additional information or explanation, the identification and discussion of key issues, the key concepts, and the students' trail. Both primary and secondary pages may be annotated with footnotes and references.

Although the Scholar's Desktop is currently being used to develop biodiversity teaching material for our consortium, it is intended to be discipline-independent. There are already plans to use it in another consortium, and it will eventually be available more widely.

TOWARDS AN INTEGRATION OF EMERGING EDUCATIONAL TECHNOLOGIES

PETER BRUSILOVSKY(*), MIKHAIL ZYRYANOV(**)

(*) International Centre for Scientific and Technical Information,
21b Kuusinen str., Moscow 125252, Russia
E-mail: plb@plb.icsti.su

(**) Department of Applied Mathematics and Cybernetics,
Moscow State University, Moscow, Russia

The recent East-West Conference in Moscow [1] listed three classes of emerging computer technologies which are of great interest for specialists on computer use in education: artificial intelligence, multimedia and hypermedia, and learning environments and microworlds. Application of these technologies into education is considered as a basis for creating the next generation of educational software [2].

Traditionally developers of educational systems consider these approaches as independent or even contradictory ones. However the approaches are not contradictory but rather complimentary. Intelligent educational systems are able to control the learning adaptively on various levels but generally do not provide tools to support free exploration and browsing through information. In comparison, hypermedia systems and microworlds provide a medium for student driven acquisition of declarative and procedural knowledge but they lack the control of an intelligent teacher. Without such control the student may never discover some important features of the microworld or the hypermedia space, and may even get "lost in hyperspace".

In some domains it is possible to achieve a good result by developing an educational computer system which integrates the capabilities of intelligent tutor or coach, learning environment or microworld, and hypermedia system. Such an integrated system should be not just a sum but a real integration of its components. This means that one component can use the possibilities of other components, and the results of a student's work with one of the components should be taken into account by other components to adapt their performance to the knowledge level and personal features of the particular student.

We suggest an approach for developing such integrated intelligent learning environments. The key idea is to use a structural domain model and an overlay student model as a kernel for integration of different components. The domain model (DM) is a network. Nodes and links of the network represent elements (items) of domain knowledge and relations between elements. DM states the basis for the domain hypermedia network and for the overlay student model (SM). SM variables corresponding to any particular node or link represent the level of the student's competence of the knowledge element or relation. All the system components may update SM to reflect the results of the student's work and may use it to adapt themselves to the particular student.

The approach was developed and tested originally for the domain of introductory programming [3]. Now, an attempt has been made to generalize the approach by applying it to the quite different domain of geography. This paper presents the Intelligent Tutor, Environment and Manual for Physical Geography (ITEM/PG).

ITEM/PG consists of an intelligent computer tutor, a hypermedia network and an environment for learning of the relationships between components of the natural complex of an island. The natural complex is comprised of nine components such as relief and climate. Each component may have one of several possible values. The educational goal is to learn the rules which connect the values of the island's components.

The rules, components and values are three kinds of knowledge elements which form the domain model in ITEM/PG. Each DM node is really a frame which represents the corresponding educational information (texts and pictures) by its slots. DM states the skeleton for the hypermedia network. Hypermedia pages for DM nodes are generated from the frames. Browsing the network is one of the ways for the student to learn the domain.

The environment for exploration-based learning was used separately for about two years [4]. Working freely with the environment a student tries to compile a consistent set of the values for the natural complex of an island selected somewhere in the Atlantic Ocean. On the student query the rule-based domain expert system can evaluate the choice and explain errors. Student success or errors are reflected in SM.

The tutor uses SM to optimize the student exploration by suggesting the "optimal" island to solve. The island is "optimal" in the sense that in solving it the student will be forced to work with the optimal mixture of well learned and unknown rules. Thus the tutor lets the student learn the subject by steps of individual size, as well as preventing the student from restricting the exploration to the already learned subset of rules.

ITEM/PG combines student managed exploration of the subject with the help of the environment and the hypermedia network with goal directed adaptive task sequencing provided by the intelligent tutor. ITEM/PG shows a way to integrate these computer technologies on the basis of represented knowledge about the domain and the student.

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NEW OBJECTIVE: MULTIMEDIA IN EDUCATION

SERGEI CHRISTOCHEVSKY

Institute of the Informatics Problems, Russian Academy of Sciences
30/6 Vavilova str., 117900, GSP-1 Moscow, Russia
Email: christ@ipian15.ipian.msk.su

There are very many computers in education in different countries now. What was the main objective for their using and what can we say about their efficiency. What are the directions for further work?

We saw the first micros at schools more then ten years ago. In general it was a political decision, only now we understand the main objestives of using computers in education. Yes, it's possible to use them for increasing efficiency of learning process, and this is very perspective direction. But now there are very little influence on learning process. More over USA use compu ters in education with great intensity comparing with Russia but nevertheless we are the first in science and math. So we think that the main aim of using information technology at schools (Christochevsky,1992) is to provide access to gigantic volumes of information in data bases, knowlege bases, expert systems, information retrieval systems, computer archives, encyclopedias and so on (we call it electronic information). It is very desirable to teach students rules of navigations in these volumes of information, find correct ways for receiving necessary information. It's also necessary to teach teachers to use alternative sources of information.

From here there are two ways for searching information: a) using electronic communication and b) using local data bases. We considered two big projects by National Council for Educational Technology (UK) concerning with 1) telecommunications and 2) CD ROM in Schools. We think that these are the first projects in which access to electronic information is on the first place and access to alternative sources of information is provided in reality. A few words about the second project. In this scheme stu dents work with local multimedia data bases (CD ROM). In conclusion Steadman, Nash and Eraut (1992) mark:

There are no quality compact discs designed for a British mar ket and many of the discs used in the scheme were criticised for an American bias;

- The next problem is cost of discs and hardware.
- Very few discs lend themselves to use with young pupils in primary schools.
- Necessary to educate staff and students.

We may add that here is passive using of information (or one-way) by students in contrast with Doomsday project for example, where they collected information about their communities.

We start a pilot project "Multimedia in Education" in Russia with the establishment of a centre for the development and dis semination of materials and training relating to the use of mul timedia technology in education. We suppose:

- Education and training of teachers and instructors in the fundamentals of multimedia systems.
- Initial using of foriegn discs and their adaptation to the Russian language.
- Production of original CD ROMs for education with participiation of students.

Our team (Fedosejev and Vichrev,1993) has developed a method of educational software predesign activity for creating CD ROM with educational orientation. We have already several projects of the first CD ROMs such as "Knight at the parting of the ways" (his- tory of Russia), "World money" and so on. We suppose a very active participiation of students in these projects and we also suggest cooperation to the foreign students through e-mail too.

More details about history of Russia. It's possible to fulfil this project also with help of students and We invite foreign specialists and students for example from the UK, Germany, Fran- ce to take part in this project too. A group of russian history teachers select key events from russian history. Then our students begin to collect the information about these events from our sources of information. At the same time these questions will be delivered to foreign students with the same request through e-mail. All the answers will be processed by a group of coordinators. After that we'll begin to construct a prototype of CD ROM and as a result we'll have the russian history with the eyes of russian, british, german, french students. In their turn our students may collect information about history of the UK, Germany, France in accordance with the requests of your teachers. If it'll be impossible to fulfil project "Knight at the parting of the ways" by this way due to lack of funding we do it without student participation.

Besides that possible activity of the Multimedia Centre includes:

- Seminars, discussions, lectures on the subject of multimedia.
- Research work on the role of multimedia in the modern information systems forming a new informative environment.
- Research on and development of instrumental and authoring multimedia systems and methods for education, which will allow the teacher to use multimedia systems effectively in the education process.

But now we are only at the beginnig of our way.

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PROTEE-A KNOWLEDGE-BASED SYSTEM TO ASSIST IN MODELLING AND TEACHING VEGETAL BIOLOGY

JEAN-MARIE LE DIZES *, PHILIPPE COUCHAT **, CATHERINE MARC **
* *TransExpert, Les Figons 13510 Eguilles France*
** *Department de Physiologie Vegatale et Ecosystemes*
CEA Cadarche, BP 1, 13108 St-Paul Lez Durance. France
Fax: 33 42 92 33 00

Keywords: Knowledge-Based Systems for Education, Biology.

1 Protee: A Knowledge-Based System dedicated to Vegetal Cellular Physiology

Initially intended for experimental researchers, Protee is quite suitable for teaching vegetal cellular physiology to students [4].

It deals with:

- Biosynthetic mechanism occurring within the vegetal cell.
- The ionic transport through the cell membranes.

The embedded knowledge has been acquired from researchers and senior experts as well as from bibliographic literature. It is both qualitative and quantitative.

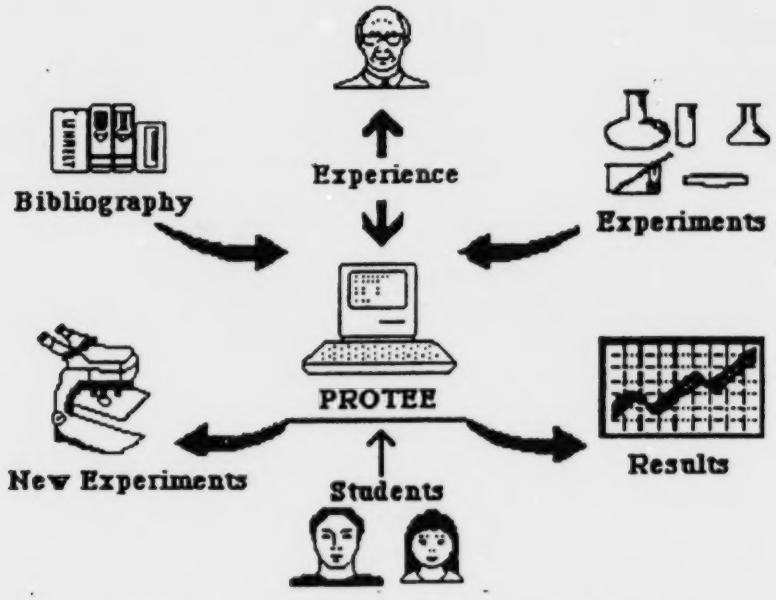

Figure 1. Protee : A tool for biology researchers and students

2 . Specific Features of Biological Knowledge

Some specific features are [3]:

- Large amounts of available on-line data.
- Extensive bibliographic scientific literature.

- Significant (but incomplete) background knowledge.
- Multidisciplinary field, requiring cooperation among various domain experts.
- Nature of knowledge:

Unlike many other areas in Science, Biology is often described in symbolic or semi-quantitative terms rather than by differential equations [1].

Like other scientific disciplines, Biology is overwhelmed with data describing various knowledge levels which are difficult to keep consistent, or the consistency of which with other levels is not readily guaranteed.

As in experimental Science, biology problems involve solutions which can be empirically verified. It is also an objective of Protee to predict and check experimental results.

To cope with the mentioned above issues, the current work has been restricted to biosynthesis and ionic transport within some specific cells: the stomata (guard cells).

Nevertheless, a such limited area provides a substantial amount of knowledge. (See below the implementation data).

3 Structuring the Knowledge Base

An object oriented approach has been used to describe the static universe of discourse.

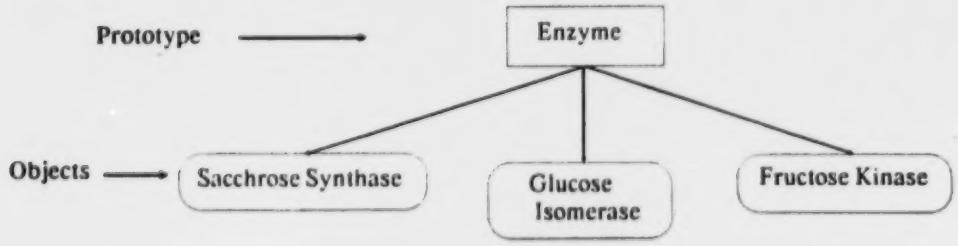

Figure 2. The Static Universe of Discourse.

Relationships and constraints between (or inside) objects are expressed in terms of production rules.

```
IF  WhiteLight is Active
    AND there is some Fructose 6-Phosphate2,kinase
THEN Fructose 6-Phosphate2,kinase is activated
       AND Fructose 2,6-Biophosphate is "present"
+
IF  PFP is present
   AND Fructose 6-phosphate2,kinase is activated
THEN 'Send Message: Consistency is OK
    AND Trigger Forward Chaining on the following Rule Bases:"FRU2,6P2" &"PFP"
```

Figure 3. Example of production rule with 2 actions: a message and a forward inference.

The dynamic process iv based on the task concept; a task is a series of goals to be reached through a backward chaining mechanism applied to rule subsets; each subset is a rule base; side-effect actions may be triggered as goals or results of activated rule; forward chaining inference is a particular case of action.

Not all rules are in the same rule base. Forward and backward chaining deductions can be applied to some specific subsets or even to some specific rules.

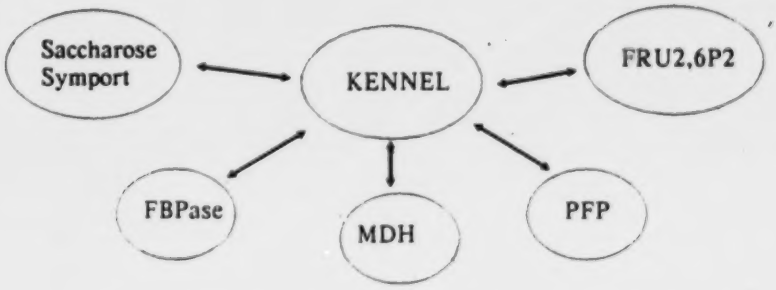

Figure 4. The knowledge base is split in several distinct rule bases

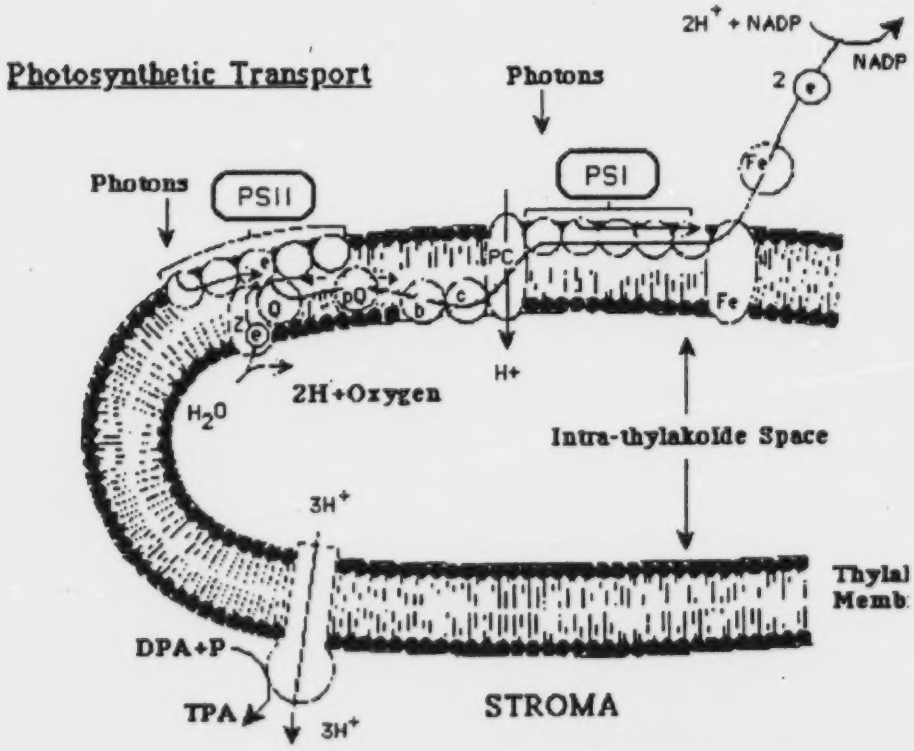

Figure 5. An example of background display. Interactive buttons which are context-dependant are highlighted.

4. Implementation data

Protee has been implemented in Prolog II (© PrologIA. Marseille-France) on micro-mini computers. Communication is provided with C modules, Excel (©) and Cricket-Graph(©).

The current knowledge base includes: 80 prototypes, 1425 objects, 6000 attributes, 2000 rules, 1400 actions and 60 tasks.

5. User Interface

The end-user is not expected to be a computer professional. Therefore, for user acceptance purpose, a great deal of attention has been paid to the user interface.

The interface is highly interactive and interactions with the biologist is mainly graphical. The version for Education is augmented with acceptable explanation features. Upon user request, for a given level of explanation, the line of reasoning is displayed.

6. Further Works

Protee development started in 1987 [2]. Since then, the knowledge base has been continuously augmented and the user interface enhanced. The application has reached a kind of no return point. Knowledge acquisition, in this area, is a "quasi"everlasting process. Although limited to a few biological mechanisms within the vegetal guard cells, the amount of knowledge embedded so far is not sufficient to fully satisfy the biologist researchers [5].

Protee base is still being extended at the CEA-Cadarache(French Atomic Research Centre), other versions are being installed at the French INRA (Institut National de la Recherche Agronomique) and at IBT (Institut de Biologie Theorique).

The Education-oriented version has been investigated with the French Ministry of Education. New developments are expected very shortly [4].

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AUTODOC A HYPERTEXT TOOL FOR VOCATIONAL GUIDANCE

JEAN-MARIE LE DIZES *, ALAIN RUFINO **, ANDRE TRICOT ***

* *Consultant. TransExpert, Les Figons 13510 Eguilles France*

** *Psycho-pedagogue, Ecole de Journalisme et Communication. Universite Aix-Marseille. 58 Bd Charles Livon 13284 Marseille. France*

*** *Cognitive psychologist. CREPCO (URA CNRS 182)*

**** *Universite de Provence. Aix-en-Provence. France*

Fax: 33 42 92 33 00

Keywords: educational hypertext, vocational guidance, cognition

DESCRIPTION

AUTODOC stands for "Auto-documentation". It means that it is aimed at providing documentation as a self service. Information provided is related to professions and trade.

The targeted users are youngsters (students, pupils).

AUTODOC provides knowledge and professions.

This knowledge falls down into five categories:

- Nature of Work.
- Required Skills and Qualities.
- Working Conditions.
- Perspective and Careers.
- Training and Diplomas.

Questionnaires are associated to each category. The user is prompted to answer questions. The answers are rated and scores are displayed along with a graphical presentation of the user performance. Through the training session, a self-evaluation feature enables the user to assess to what extent he has increased his(her) knowledge.

The tool is user driven. The hypertext nature of AUTODOC enables the user to navigate through the tree-like structure of the set of screens. Moreover, depending upon the user performance, some "hot words" are highlighted in the profession presentation to intent the user to pay more attention on some specific features and get more detailed knowledge.

Much care has been paid to the youngsters mental representations. The language used in the description of professions (and in the questionnaires as well) has been carefully selected to reduce as much as possible, any semantic ambiguity. The underlying cognitive process of a pupil, in a training session, have been taken into account to reduce his mental load, to keep up his attention, to detect and correct any misunderstanding and any false preconception.

WORK DONE SO FAR AND FURTHER DEVELOPMENTS:

AUTODOC is a project sponsored by the French Ministry of Education and ONISEP (Office National d'Information sur les Enseignment et les Professions). It started in 1989. An operational use is expected before the end of 1993. The professions are clustered according to 16 topics (topics are called "entry keys"). Entry keys are, for example: Educational professions, health professions, Take care of people, travelling... A total of 200 professions will be implemented by the end of 1993. Each profession requires about 50 screen.

The tool will be first installed in the 600 CIO (Centre d'information et d'orientation de l"ONISEP) distributed on the French territory. Further, it will be installed in the French school units (Lycees and Colleges) to help the pupils getting some guidance in the choice of a profession.

AUTODOC is implemented on a PC computer. It is run under DOS. It requires a color display monitor. It can be run through a network. The stand-alone version requires a hard disk.

Prior the implementation, much experimental work has been done to determine what are the best navigation and learning strategies. Many people, specializing in vocational guidance have been involved in the scenarios presented in AUTODOC. Many pupils have experiences test panels to evaluate the first prototype tool.

A further feature is to connect a movie sequence peripheral (such as a CD-Rom or Video-disk) to provide the user, upon his request, with animated sequences dealing with some topics. For instance, a nurse at work in a hospital, a veterinarian at work in a rural area.

STRATEGIC TEACHING FRAMEWORK: A HYPERMEDIA SYSTEM TO SUPPORT STRATEGIC CLASSROOM CHANGE

THOMAS M. DUFFY (*), BEAU-FLY JONES (**), RANDY KNUTH (**)
(*) Indiana University, Bloomington IN USA
(**) North Central Regional Educational Laboratory, Oak Brook, IL, USA

Overview

Strategic Teaching Frameworks (STF) is a multi-media resource being developed to aid teachers and administrators in adopting new approaches to teaching. It can be thought of as a "library" of classrooms that portray expert teachers implementing cognitive approaches — approaches that are learner centered and problem based. Underlying each classroom is a database of information that helps teachers to develop a mental model of the instructional approach being demonstrated and to develop the capability for implementing the strategy in their classrooms. STF currently focuses on classroom activities; later components are planned to be administrator based.

The metaphor underlying STF is one of apprenticing the teacher in another teacher's classroom. The apprentice basically finds a teacher whose approach, content domain, and grade level is compatible and then "sits in" on the class, watching as the instruction unfolds. He or she can find the answers to commonly asked questions in the system or solicit alternative points of view from STF at anytime during or after watching the class. The theoretical basis for STF's design is informed by the growing research in cognitive psychology and constructivist pedagogy. The approach of Strategic Teaching Frameworks is based on the assumption that teaching is an integrated activity. While the parts can be understood separately, the teacher must have an integrated model of what he or she is trying to do in the classroom in order to achieve a unified whole. This is a reflection of current theories on domain-dependent learning (Brown, Collins, Duguid, 1989; Duffy, Jonassen, 1991; Bednar, et al, 1991). These same principles should be applied to teacher training. To this end, teachers using STF encounter new teaching strategies in the context of a real classroom setting.

Cognitive apprenticeship (Brown, Collins, and Duguid, 1989) provides a second basis for the design of STF. The teacher in the STF video models the effective teaching behavior. Further, reflections by that teacher and other experts help to focus attention on relevant aspects of the teaching approach. As the teacher using STF tries the strategies reflected in the video, he or she can return to STF to compare performances. Physically, STF is a computer system and software that controls a videodisc player and a CD-ROM player. STF relies heavily on video to provide realistic representations of classrooms in progress. In time there will be a library of classrooms in all major subject areas and age groups. The prototype focuses upon elementary mathematics instruction. When teachers enter STF, they begin by identifying the content and grade level of the classes they are interested in . The program will then provide a brief description of alternative classrooms that meet the user's criteria. The teacher or administrator may then choose to view a short vignette of one or more classroom alternatives from the video library. Then, when a classroom framework is selected, a full class session is viewed with the primary emphasis on getting a general sense of the class. Viewing the classroom session marks the beginning of training or assistance. The teacher may

then select from a variety of resources to gain an understanding of the particular interplay of strategies in the classroom, the techniques and problems involved, the planning required, and the alternatives available.

The Components

1. The Video Classroom

In starting an STF module, the teacher or perspective teacher is presented a menu identifying three master teachers and classrooms that are available for that grade level and content domain. The menu is designed to aid the teacher in efficiently browsing the alternatives to identify the one that is best matched to his or her interests and style. At a first level of browsing, there is a brief written description of each class identifying grade level and the basic characteristics of the approach. At a second level, the learner may select a preview of each class. The preview is approximately 2 minutes of video and audio providing a view of the class along with the teacher's description of the approach used and the kinds of success achieved. The system is built around the videos of the classrooms. After the user chooses a specific classroom to observe, the system immediately provides the user with the opportunity to view the video of that expert teacher in action for a whole lesson. Instead of isolating and decontextualizing instructional strategies, this whole classroom approach provides a view of the strategies in their full context along with providing a broader perspective on the culture of the classroom.

2. Expert Perspectives

At any time, the user can receive commentary from the teacher in the video, other expert teachers, and researchers. These commentaries may criticize, explain, provide research support for, or suggest alternatives to the particular instructional activities being viewed in the video. Much of this information will be given in audio and text using a "think-aloud" format. In effect, the expert teacher and other researchers are modeling their approach to planning, monitoring, and evaluating instruction.

The issues that the expert mentors address are not predefined. Rather, each expert identifies what he or she feels are the important factors in the flow of the teaching. In our prototype system we have Ms. Bill reflecting on her own teaching; a mathematics educator commenting on teaching from the perspective of "learning" mathematics; and a general methods instructor focusing on the more general methods and the behavioral strategies of the teacher. Rather than predefining the relevant issues for the learner, we want the learner to build on the multiple perspectives of the experts and construct his or her own perspective of the critical features of the instruction.

3. Notetaking

At anytime the learner can attach a note to any segment of the classroom video or to any item in the database. The learner can use this feature to mark important events, add his or her own perspective, include new data not currently in STF (e.g., a reference or summary of some relevant evaluation), and create a collaborative environment in which fellow teachers use the electronic notes to evaluate and discuss features of the instruction.

4. The Database

At any time, the teacher can access a database of information designed to obtain guidance on specific issues related to the teaching approach in the video. While all other information is organized around the classroom (viewing the classroom, obtaining commentaries on it, and entering one's own commentaries) the database is organized around instructional issues. There are articles, audio interviews, and video on specific topics listed under the broader headings of: classroom management, assessment, teaching strategies, content organization, planning for classes, and planning for change. This issue orientation allows the learner to access both practical and conceptual information to assist him or her in working through particular issues as they attempt to restructure their teaching.

Platform Requirements

STF runs on a Macintosh computer with at least 4 megs of RAM. The video is stored on videodisk and the audio and text components are stored on CD ROM. In the near future the entire system will be on CD ROM.

HELP GENERATOR: AUTHORING TOOL FOR CREATING HYPERTEXT DOCUMENTS IN MS WINDOWS

GVOZDJAK P., MASIK J., NOVOSAD T., PARADA M.,
SYKORA M., SKOPEK P., VITTEK E.
Faculty of Mathematics and Physics
Mlynska dolina, 842 15 Bratislava Slovakia
E-mail: kravcik@mff.uniba.cs

Keywords: educational multimedia, help generator, authoring tool

Preface

Students and workers of our faculty have indeed no comfortable and effective tool to write their own hypertext documents such as texts of studies, informative systems or documentations and helps to their programs and applications. We have also never met with such a tool anywhere else. That is why our student group under the leadership of Milos Kravcik has decided to make up a system for creating hypertext documents in MS Windows system - Help Generator. The main reasons that led us to chose MS Windows is its accessibility and existence of comfortable tools for writing (Write) and reviewing documents (Help system of MS Windows). An advantage is that these programs belong among the standard applications of MS Windows thus they are accessible in every installation of this system. MS Windows is currently very used environment on personal computers, so we assume sufficient familiarity of using its main applications among our students and workers. Another reason why we decided to make our system in MS Windows is that it should be capable to work with graphic information.

Our system is composed of these units.

- Creating of hypertext project.
- Checking of validity.
- Editing.
- Compilation.

Single units will be described in details later. User of system first writes chapters of his documents in MS Windows Write. We wanted to ensure that in this state he would fully pay his attention to formatting texts and graphic information not to the complex structure of hypertext document. Next he enters our system where he can build up all the structure of his document and compile it into RTF format. At last he compiles RTF file into MS Windows help file via Help Compiler. The single parts will be accessible through main program unit.

Creating of hypertext project

Input: Chapters stored in files in one directory; output: Empty structures for Help Generator.

Under the creating of project we mean initialization of all the structures used by Help Generator. It covers selection and reading of all the files of hypertext document. System assigns empty names to all the chapters and creates empty structures for storing keywords, links and browsers.

Checking of validity

Input: Structures of Help Generator; output: Error messages and warnings.

This unit provides checking of various features of hypertext document. On a request it checks the names of chapters, whether all the chapters have assigned names, whether there exists any chapter accessible only through keyword, it finds chapters that are not referenced through links. If error occurs it requests user for the proper data. Another checking deals with the contents, whether it exists, whether there are links from contents to separate chapters. Checking can be considered as precompilation that should shorten the time necessary for creating hypertext document itself. This modul should check even some features that are not checked by Help Compiler.

Editing

Input: Structures of Help Generator; output: Modified structures of Help Generator.

This unit should provide change, adding and deleting of links in chapters as well as change of contents of a chapter. If user wants to change the contents system calls the text editor (Write) and after editing it checks the changes and stores them into the structures of Help Generator. Links in chapter must be marked in editor by underlining. Of course system asks user for goals of links after the end of editing. User can also edit links in chosen chapter. Links are organized in a table and user can specify goals for them. User can also add, delete and edit keywords and set of chapters relevant to the specific keyword. User can also interactively create browsers.

Compilation

Input: Structures of Help Generator and chapters of Hypertext document.

Output: Hypertext document in MS Windows Help format (.HLP).

The first all the information stored in structures of Help Generator together with the text and pictures of chapters is compiled into one file in RTF format. This file is at last compiled through Help Compiler. Help Compiler is provided together with IDE's for MS Windows.

Conclusion

We want to point to another advantages of this solution as saving the disk space (Help Compiler provides compilation to compressed format), the whole document is stored in one file (it is easy to distribute texts of studies) and at last we assume that MS Windows is a perspective environment for developing applications as well as educational work.

ENHANCING THE EVALUATION OF MULTIMEDIA LEARNING MATERIALS

TERRY KING
Computers in Education Research Group
Dept of Information Science University of Portsmouth
Milton Campus Locksway Rd, Milton, Southsea, Hants, UK P04 8JF
E-mail: kingtr@uk.ac.portsmouth.csovax

Keywords: evaluation, CAL, CBT, multimedia, hypermedia, CD, cognitive models, communication, learning theory

The European Commission is currently funding major research projects in educational issues under its DELTA programme. These relate particularly to the creation of effective learning environments based on the use of interactive computer systems. Since 1992, one of these projects has been examining the Integration of Learning Design in Interactive Compact Disc (ILDIC). One of the major aims of the ILDIC project (which involves partners in the UK, Greece and Denmark) is to produce standards for the design of learning applications on interactive CD. In order that such standards can be produced, well designed prototypes of learning materials are being produced for CD. The design principles are based on a model of learning design which has been derived from both learning theory and actual practice.

During 1992, in order to investigate the quality of learning design in practice, a team from the University of Teesside (of which the author was coordinator) carried out an evaluation of forty-three products, all of which were multimedia products which used CD as the dissemination and delivery medium. The team derived a category based evaluation tool with prompt questions derived from expert opinion which was applied quantitatively using a method of competitive analysis (King and Barker, 1992; Barker and King, 1993).

Conceptual models of instructional and learning design can be considered to have at their foundation four theory bases - general systems theory, conceptual models of instruction, learning theories and communication theories (Richie, 1986). The derivation of categories and the prompt questions in the ILDIC evaluation tool drew extensively on the first two of these foundations being primarily concerned with such issues as gaining and holding attention (engagement), feedback and pacing (interactivity), presentation and the quality of the human computer interface (quality of interaction and end-user interface), evaluating learning outcomes and rediagnosing learner needs (monitoring and assessment and built-in intelligence) and various aspects of learner-focused modelling (tailorability, learning styles, learning support tools, etc). Very little of the evaluation work drew from learning theory and none at all from communication theory as it can inform on the use of various media in multimedia products.

The paper seeks to re-evaluate, amend and extend the original evaluation tool for learning design in multimedia learning materials used in ILDIC by reference to recent developments in cognitive psychology, communication theory (as it relates to the use of new media in education) and, where relevant, to find areas of common ground where one theoretical approach enhances the other. The will involve consideration of the implications for learning design of theories of constructivism and constructive interaction (and their importance for consideration of the use of software within a social or group context), social aspects of learning and the work of L.S. Vygotsky (1978) (specifically his concept of the zone of proximal development and how that has been developed in ideas of temporary cognitive support), meta-cognition (and in the inclusion within software of aids for the development of self-reflection and self-assessment) and mental models and their use in moving a novice to a level of expert understanding. The role of various media as communicators of information will be examined along with new media theories. New media is used in this context to refer to the broad class of communication technologies which have recently become available for education courseware, such as high quality audio and static pictures, and moving video sequences on CD-ROM, CD-XA, CD-I, CD-TV etc, as well as interactive video (IV) and the use of compression techniques in conjunction with digital video interactive (DVI). The paper will make reference (among others) to media theories concerning the social presence of a communicating medium and attitudinal dimensions connected

with specific media. Along with the link between these in the form of social constructivism and 'personalness' of media.

The paper will include a qualitative evaluation tool for the learning design of multimedia courseware derived using work from these additional foundational areas and initial results from the evaluation of multimedia products on CD using this tool.

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COMPUTER INTERACTIVE METHODS FOR TEACHING PAINTING STYLE

JOAN L. KIRSCH[(*)] , RUSSELL A. KIRSCH[(**)]
(*) Sturvil Corp., Clarksburg, MD, 20871-0157, USA
(**) National Inst. of Standards and Technology
Gaithersburg, MD, 20899, USA
E-mail: kirsch@cme.nist.gov

Keywords: fine art, Joan Miro, grammars, formal language, computer graphics, Macintosh, expert system, knowledge representation

Art educators, museums, and books abound in their efforts to convey an understanding of artists' styles. The lessons taught may ultimately rely on inference and are rarely explicit. But without suitably expressive tools to explain style, no alternative seems possible. Such tools are now available using interactive computer based methods for enabling the student to explore a painter's style. The student is allowed to create compositions with wide variations, but the computer forces these variations to be consistent with the style being taught.

Although computers, as a medium, are being used prolifically to create new art, our research examines techniques for understanding pre-existing paintings. This work is predicated on the use of techniques drawn from the fields of computer graphics, formal language theory, and syntactic pattern recognition. From computer graphics, we use methods for interactive drawing of the kind widely used in computer aided drawing. From formal language theory, we use ideas from grammar theory. From syntactic pattern recognition, we use ideas that we introduced over 25 years ago to define classes of images in terms of their syntactic constructional history.

Through these methods, it has become possible to analyze the structure of a painting and, with suitable algorithms, to create new examples of the artist's style in order to test the theory. This same generative method can be controlled by a student who wants to learn about the style. By exploring the options available as the algorithm generates new compositions, the student is led to a deep understanding of the painter's style. In effect, the student learns by trying to behave like the artist with the computer guiding the process to guarantee success.

The study of two very different artists will clarify our approach. Richard Diebenkorn, a major living American artist has, over the past 30 years, painted a series of over 140 oil paintings called The Ocean Park Series. They are large abstractions of California landscape based on a roughly geometric

division of space. Our task was to discover the fundamental processes of linear composition of these paintings that make them uniquely Diebenkorn's. We wrote a picture grammar to describe the parts of the painting and the rules for assembling them. It was implemented on a graphic workstation. The grammar was used to generate many examples from the unlimited number of possibilities of the artist's style given by the grammar. It was even possible to generate compositions which turned out to be similar to actual ones painted by Diebenkorn that we had never seen.

The late Spanish Surrealist, Joan Miro, produced, in 1940-41, a series, called The Constellations, of 23 paintings which are space filling containing organic abstract shapes. Our task here was to uncover Miro's fundamental gesture that informs all his shapes. With algorithms for these gestures we can build the shapes. The shapes, in turn, are inserted into compositions that must obey Miro's compositional rules. This work is being done on a Macintosh computer, thereby making it potentially widely available to the large public interested in art for whom this small personal computer is available.

Similar work by other investigators has produced grammars for the artists Mondrian, Vantongerloo, and Stella. Such grammars could obviously be written for artists like Malevich, Kandinsky, and many others. But none of these efforts has been interactive in our sense.

Using these formal techniques for eliciting heretofore unarticulated processes by the artist has vast educational ramifications for teachers, scholars, and artists. Teachers can use their understanding expressed in algorithmic form to make painting style better understood by their students. Scholars can use these methods to recognize affinities and influences among different artists. And artists can use algorithms from other artists in their own works to enrich them.

THE MAIN ASPECTS OF HYPERMEDIA CREATION AND DEVELOPMENT AS EDUCATIONAL PROCESS

D. KLOCHKOV, S. KRYLOV, V. KOSTRUKOV
State University of Nizhnii Novgorod
E-mail: dim@liso.nnov.su

Keywords: hypermedia editor, GUI interface, education, design, object oriented programming.

This report consist of three parts. The first describes hypermedia editor have constructed by authors. This editor provides writing and reading texts, graphics, pictures, executive modules, comfortable GUI interface, every time accessed help and possibility to advance this product. There are very many features making work with editor easy and pleasant. The editor deal with some text and graphics formats. The hypermedia structure can be drawn multicolored and searched in different directions. The ota Bene system provides possibility to point any element of structure and return to it by special methods (hot key, additional menu and so on). This editor works on IBM PC AT and compatible computers and may be used to design educational systems and computer books.

The second part includes proof of educational profit of creation hypermedia editor by students. Authors look at programming problems solving by work executor and acquirement experience during design and debugging the large scale reliable software. Students work was organized as Chief Programmer Team based on up-to-date technology of software engineering - object oriented programming. The conclusions are confirmed examples of real work have been performed in University of Nizhnii Novgorod. This part regards most important questions have been asked by students and difficulties have been surmounted by them. Authors gives theoretical explanation of above information.

The third part is the part of authors wishes and plans for future and dial with methods and possibilities to adapt editor for MS Windows and new educational problems for students. In conclusion report includes list of interesting features of editor that may be generated.

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IDEOLOGY, MULTI-PERSPECTIVENESS AND CONCEPT REPRESENTATIONS FOR HYPERMEDIA DESIGN

PIET KOMMERS
University of Twente
Faculty of Educational Science and Technology
Division of Educational Instrumentation
p.o. Box 217, 7500 AE Enschede, The Netherlands
E-mail: TOKOMMERS@UTWENTE.NL

Hypermedia have brought flexible ways of accessing multimedia information. This flexibility is not only important from an ergonomical point of view. It challenges educationalists to rethink the basic assumptions in theories for learning and instruction.

Two basic ideologic lines have been present in educational practice for a long time:

1. The notion that learning processes should be optimized and facilitated by a cybernetic approach. The most obvious way to do that is to give behavioral guidance to students, and to control the timing and sequence of new information and (prerequisite) skills to be mastered. From a management point of view this approach is quite attractive as it stimulates teachers to be quite explicit what they expect from their students. Planning estimations can be made, tests and subsequent decisions become lucide. Behaviorism has reinforced this view on learning and has triggered a long tradition of so-called programmed instruction. It is not surprising that new media like computer-based training and knowledge-based systems are immediately taken up by educationalists to amplify the cybernetic teaching approach. Now as we have all the rule-based programming tools to define instructional decisions we soon become aware how few evidence we have concerning concept dependencies in human learning, and how few we actually know about the mechanism of learning. Optimizing only the sophistication of inference- and decision algorithms for instructional control of learning looks a bit like making more and more rules and laws as a try to improve the cooperation between people in a society, without addressing the level of awareness, motivation and creativity of the personalities who really have to do it.

2. The notion that learning is for a major part a self-organising process which is highly due to reflection, self control and 'learning to learn'. Especially when it concerns conceptual knowledge which need many examples and can only be internalized by embedding them in several contexts, the complement to cybernetic approach becomes evident and brings us to learning activities as simulation, exploration, discovery, cooperation, negotiation and last but not least reflection with concept tools for semantic networking, concept mapping, synthesizing overviews, taking different perspectives and arranging communication with experts and with other students.

It is this second aspect of learning that gets a chance by using new media like hypermedia, concept mapping, multimedia communication and virtual reality. After few years of exploring the facilities of these tools, it might become realistic to think about consolidating procedural control how and when to use these tools in cognitive development and learning in with the kind of mechanisms we now try to use to control the delicate steps in individual learning. The role of the computer will then have the function of traffic lights, booking / administrative register and bulletin board for a variety of communication and consulting functions between human participants. The medium is then a help to overcome time constraints and collisions in communication, rather than a 'pedagogic' emulation which restricts the freedom for the students as it works out now in many of the computer-based programs nowadays.

The body of my presentation will address the spectrum of cognitive tools we have now available to give to students. The basic assumption is that cognitive tools allow the student to externalize mental activities so that he/she becomes aware of them and makes them communicable to other students, teachers or external experts in the field.

Three basic kinds of cognitive learning tools can be distinguished:

- Simulation environments enabling the student to explore extreme situations to discover and experience a target system.

- (Multimedial) communication systems to allow cooperation between learners in a similar phase of study, and to promote cooperative problem solving.
- Knowledge representation tools.

These last ones will be discussed in greater detail, in relation to the previously introduced notions of self-organisational learning, reflection and exploration. Knowledge representation tools allow for instance concept mapping, semantic networking and knowledge elicitation programs. They enable the student to draw (logical) consequences from given facts and rules. The choice of the representation formalism and the level of expressiveness in the primitives of the tool should not only be based on the structure of the domain to be learned, but above all on the target level (precision) of learning and the level of cognitive development of a particular student.

In the Netherlands a four year project was performed with 6 teachers in the field of History, Native Language, Art Theory and Social Science. Two didactic strategies were explored:

- Concept mapping tools for activating prior knowledge before new topics were lanched, and concept mapping as a synthesiser device (graphic epitome).
- Concept mapping as a navigation tool to browse through large encyclopedias.

The paper presentation will present the concept mapping tool TextVision which is based on graph theory, and will describe the didactic and instructional impact during its introduction to the teachers and students.

HYPERTEXT-BASED SHELL FOR DEVELOPING MULTIMEDIACOMPUTER-BASED COURSES AND HYPERBOOKS

S.M. KONOVALOV, A.B. KONONENKO & A.Y. LASTOCHKIN
Russian Academy of Administration
84 Vernadskogo av., Moscow 117606, Russia
E-mail: KSM@RAA.MSK.SU

Keywords : hypertext, hypertext-based courseware, multimedia, author tools, learning course

Introduction

We describe our original hypertext-based author software for development multimedia applications such as learning interactive courses and hyperbooks. We show potential of this development kit on examples of learning courses "Multimedia Tools and Application Examples" and "Human and society - global problems". Our courseware and first course were made in Federal Program "Informatization of education" and had been showing on exhibition "Multimedia- 92" in Moscow (November, 1992). Now we create a hyperbook " How to pursue the business conversation" using our courseware.

Background

This work is part of the Advanced Multimedia and Distance Learning Platforms group at the Center of Emerging Computer Technologies of Russian Academy of Administration by Russian Government. AM&DLP's goal has been to develop technologies that would integrate multimedia and video into traditional pedagogical technologies.

The Author Tools

The main goal in the design of our courseware has been to develop a tools for creating hypertext applications with using graphics, video and audio, not expensive and simple for ordinary users. The

main part of courseware is interpretator of the special command such as "TEXT", "FIGURE", "BUTTON", "HOTREGION", e.t.

Each of those commands describes box of text, PCX-image, button or active area for mouse on screen. There are some commands in section describe visual frame (VF). VF is connected with system's buttons of control on the screen. Text boxes can include hypertext pointers. Visual image of the hypertext pointer is a button in the text box, included key-words. All kind of boxes (text,PCX-image, button and active-area for mouse) may be intersect.

Each control button, hypertext button and active area for mouse has connector with suitable section. The system of those connectors describes the logical structure of the application.

There is re-translator of special commands to control multimedia devices (for example, DVA-4000 (Digital Video Architecture) with MIC-system by VideoLogic) in hypertext-based shell.

The hypertext-based shell is written in C for the IBM PC with video adapter VGA.

KNOWLEDGE REPRESENTATION MODELS FOR INTELLIGENT LEARNING SYSTEM

V.A. KRAVCHENKO, O.V. EVSEEV & S.M. MAZURINA
Moscow institute of electronic and mathematic, AIPU chair,
B. Vuzovsky 3/12, 109028, Moscow, Russia
E-mail: root@onti.miem.msk.su

Keywords: intelligent learning system, knowledge representation model, semantic network, hypertext, navigation, Petri net, the sequence of study

Knowledge representation models form the basis of intelligent systems and determines their efficiency. Semantic networks are one of the most expressive forms of knowledge representation for closed object domains described by simple statements. However, in learning systems we deal with large information messages and the attempt to represent this information in the form of multiconnected semantic networks describing different chunks of knowledge may result in very large and complex models, which would not be satisfactory enough for data processing in the system.

In order to use semantic network mechanism for object's domain representation in the learning system we pick out basic concepts of educational course and construct a semantic network using these concepts connected by the following relations: "to be the basis of", "to be associated with", "to be an analogy for". It is possible also to use any additional relations defined by the tutor in the networks. Such model is very useful for representation of basic relations between main concepts of educational course and for describing the logical structure.

But at the same time it would not be satisfactory enough to associate textual definitions of course basic concepts to network vertexes in order to get perfect representation of education materials. In order to solve this problem we offer the following algorithm for constructing the model. The course is splited into small topics. Basic concepts are defined for these topics and their network connection is constructed. The defined collection of topics with basic concepts may be regarded as hypertext structure. Every basic concept is referred to the topic defining this concept. All topics containing the given concept can be associated with one another and with the topic which gives definition of the concept. These factors determine the possibility to look through the definition of incomprehensible term when studying any topic and to find easily all the topics where the term is mentioned.

The problem of specifying the sequence of topics to be studied is very important for learning systems. It seems to be necessary to place some restrictions on the sequence of studied topics even in the situation, when the order of study topics is free versely defined by the student. One can determine the sequence of studying topics exclusively on the basis of semantic network described above. But two questions came up here:

- Several alternative topics to be studied may exist at one the topics and the same moment;
- Some topics may not contain any concept definitions and thus these topics will not be represented in the conceptual network.

There are many possibilities to solve the first problem. Among them are: using a randomized choice of concepts to be studied; using the free versely defined learning program; using the concepts' priorities. However these approaches can not be used to solve the second problem.

We suggest here a method, which gives an opportunity to overcome the difficulties described above. Topics are connected one with another and form a Petri net. This Petri net gives a possibility to set necessary requirements to the order of topics' studying and to express AND/OR conditions for starting to study the next topic. A set of states of the Petri net positions can be used as a component of student's model for describing current states of the learning process.

To improve the testing process the system uses declarative and procedural knowledge representation models. The procedural component is represented by rules specifying the adoptive testing algorithms.

Given representation models allow to organize the decision-making process in the system efficiently and also make it possible to verify automatically the information model of the system by matching the logical structure of conceptual network with Petri net of topics. Presented model provides a satisfactory base for realizing the following opportunities in the process of learning: a traditional sequential studying of topics; returning to initial definition of any studied concept; looking through all topics referred to the concept or theme being studied; navigating through the concepts associated with given concept or connected with it by relation of analogy; determining a strategy of studying the amount of information relative to the given concept.

NONTRADITIONAL USING OF HYPERTEXT IN THE EDUCATION

D.L. KRECHMAN, I.V. KOTELNIKOV
St.-Peterburg State Electrical Engineering University, Russia
E-mail:leti@sovamsu.sovusa.com

In the paper it's consider employing hypertext and hypermedia system in the education. Main accent made at using instrumental system HyperMethod in creating and verification teach- and guide- courses, at analysis relations between parts of teach-material, and at automatical conspect generation.

HyperMethod allows to create different systems by hypertext methodology from text-, graphic-, simple animation- and sound- fragments.

Special tool BrowserHM represents integrated view at creating teach -material and allows to analyze it on different parts.

There is an significant feature of this program to search paths between units of the teach-material. So by building of array of such paths from node "The beginning of learning" to node contained something meaningful, author may see are there enough or not ways of task solution in material, and consequently is there material or sophisticated or simplified.

Author support - one from important qualities of the system. Besides "simple" path search the system may find bottlenecks and cycles which intricate course.

Not less significant feature of the system - a text synthesis on ground of existing hypertext data base.

So if we have hypertext data base which contains description of some object region and base which contains information about teach- material building, we can automatically create a linear text of concrete teach- material. For example, we have hypertext data base of history of literature and we

want to prepare lecture on antique literature and to receive its conspect contained all necessary materials by methodical order. For solving such problem that is enough that will do to connect hypertext data base with description of an abstract lecture, to define necessary minimum of information by BrowserHM, and the system will automatical create draft lecture by rules of lecture building.

We had created lectures on marketing and information business, short course on astronomy, programming by this tool.

The system lets to estimate results of working of teachered and to draw conclusions and recommendations.

MULTIMEDIA TECHNOLOGIES IN MEDICAL EDUCATION

V.M. MOROZ, I.I. KHAIMZON, R.F. MISHCHENKO
Vinnitsa Medical Institute
Vinnitsa, Ukraine

Because of their specific features medical activity and medical education are an ideal field for applying multimedia technologies. Such features are following:

- Exacting on teaching and learning medical knowledge.
- A human get more than 90% of information as visual information.

The objects under consideration are physiological and pathological processes of a living organism which as a rule have not rigorous mathematical description. It must to present a lot of factual material including video and audio information.

It is well known that a student would have the best way to learn medical activity when he/she would be near a patient's bed. But this learning method is very limited due to high speed of some pathological processes, absence of patients with disease being learnt, etc.

Thus, multimedia technologies, which allow using video materials of real physiological and pathological processes, animation, hypertext and sound in computer-based tutoring systems, can improve the effectiveness of learning process.

As an example of multimedia technologies application to learning we can present the tutoring system called "Operation for catheterization vena subclavia" which was developed in the center of New Information Technologies of Vinnitsa Medical Institute.

The system includes the following topics:

- The sequence of all stages of operation which consists of operative acts, animation fragments presented on the scheme of topographic area with demonstration of photographs of key moments in parallel.
- The dynamic spatial model of the operation main stages, that gives the student the information about the lay-out of osseous and vascular reference points which are not visible in real situation.
- Textual description of operation acts.
- Demonstration of videomovie on computer screen.

During the system development we have used the following hardware and software: PC-486DX/33, VideoBlaster, VideoVGA, SoundBlaster, Action for Windows, 3D-Studio, Animator-Pro, TempraPro.

Taking into account our experience for creating multimedia tutoring systems we can conclude the following:

- Using video and audio information does improve the effectiveness of medical tutoring/learning systems because of specific features of medical knowledge.
- The new possibility is arrived for visualizing simple spatial model of anatomical formations. It is very important for teaching medical manipulation techniques.

HYPERMEDIA AUTHORING SYSTEM

S.V. NOVIKOV, A.V. GALKOVSKY, V.A. GRUSHEV & R.A. RAZUMEEV
Minsk Radioengineering Institute
Minsk, Belarus

Keywords: authoring system, database of hypermedia learning material, database management system, hypermedia learning system, hypermedia technology, knowledge representation, object-oriented technology.

Hypermedia systems are perspective tools for computer technology to education. The field of the application of hypermedia technology is strongly concerned with the problem of finding efficient way to share the efforts of courseware development among authors. To create the high-quality hypermedia teaching systems the effective authoring tools are needed.

An authoring system is intended to provide high-level support for designer of hypermedia. This paper describes an approach to courseware development based on the concept of object-oriented knowledge representation and database of hypermedia learning material. A database of hypermedia learning material is a repository of hypertext, pictures, animated images, domain knowledge representations, references to the external programs.

Data managing performance is greatly depended the selection of database management system (DBMS) which should specific requirements. Because of this, the special DBMS, oriented to CAD systems, multimedia and hypermedia systems and other nonconventional applications, was used in the authoring system. It's ideology is based on some main ideas, such as complex information object support, object-oriented data representation, special (graphical and binary) data type support, ideological integrity with universal programming languages. This DBMS provides universal data interface for the authoring tool components.

The objects of learning material are the basic units of database. The objects are endowed with unique attributes provided with a good capability of accessing interesting information. The object attributes include:

- Identification (the type of object, the name of object).
- References associating each particular object with concepts.

The materials making up the objects which authoring system uses are created with a set of specialized editors: the text, hypertext and graphical colour editors, allowing the creation of the dynamic images. Special expert system provides flexible navigational and access mechanisms to control the database of hypermedia learning material. Knowledge representation is used to solve the navigation problem. The authoring system uses simple artificial intelligence techniques to represent knowledge of the high-level structure of course, and to model leaner's knowledge as a subset of that representation. The author creates a set of concepts to be learned, then links the object of learning material to the concept via keywords. On the basis of the network created between concepts and objects, system makes decisions on their presentation order at run time, depending on the student's responses. These decisions are also based on a set of teaching rules which operate on a dynamic student model.

Prototype of the hypermedia authoring system is being designed now using object-oriented programming technology (C++ programming language). It is now being tested as a tool for courses development on the CAD disciplines.

THE ACSE MULTIMEDIA ENVIRONMENT FOR SCIENCE EDUCATION

JOHN F. PANE, PHILIP L. MILLER
Carnegie Mellon University School of Computer Science
5000 Forbes Avenue Pittsburgh, PA 15213 USA
E-mail: pane+@cs.cmu.edu

Keywords: learning environments, multimedia, science education, scientific computing, simulation, education technology

The Advanced Computing for Science Education (ACSE) project is a collaboration among Carnegie Mellon University's Department of Biological Sciences, Center for Light Microscope Imaging and Biotechnology, and School of Computer Science. The ACSE Project is work in progress supported by National Science Foundation Grant Number MDR-9150211. ACSE is producing a science learning environment and associated lessons called Volumes. The Volumes are multi-media hyperdocuments that include text, high quality graphics, video, animation, three-dimensional stills and movies, and sound. Each Volume is created in collaboration with a scientist, and provides a focused, in-depth journey to the frontier of knowledge in the scientist's current research area.

ACSE promotes a style of learning and scientific inquiry that is not available in other computer-based learning environments for science. The feature that distinguishes ACSE from other efforts is that students are able to go beyond what has been built into a Volume, even beyond what the builders of the Volume anticipated during its creation. This is because the centerpiece of each Volume is a program representing a scientific process through simulation, and this program is open to modification by the student.

Scientifically relevant portions of this simulation are freely interspersed with the other media to form a literate, highly informative lesson. The simulation is open to student modification, and the lesson encourages such experimentation. The learner is invited to extend the central theory or to pose alternative hypotheses, and to test them by modifying the simulation and running it. The Volume focuses the learner's attention on those aspects of the simulation that are scientifically important, while hiding the larger portions that are irrelevant to the science.

One of the core goals of ACSE is to promote the use of a programming language to convey structured scientific information. The obvious advantage is that this kind of scientific discourse is executable. ACSE investigates whether student scientists with one semester of computer programming experience can do research and publish their results in this way; whether a learning environment that features programming in this way enhances student learning; and whether it stimulates student interest in the sciences by bringing them to the exciting forefronts of current knowledge.

The sprinkling of simulation code throughout the Volume promotes the programming language to the same level as natural language, math, pictures and diagrams for conveying scientific information. ACSE boldly asks science students and teachers to use programming as a way to talk about science and to simulate experiments. In order for this to be a success, the simulation programming effort must be supported as much as possible.

The ACSE environment has this support because it is built upon the Object Pascal Genie from the MacGnome Project of Carnegie Mellon University's School of Computer Science. The MacGnome programming environments were supported in part by National Science Foundation Grant Number MDR-8652015. MacGnome built, evaluated, and disseminated a family of novice programming environments, known as the Genie environments. These are integrated systems built around a structure editor. They are built for the novice user and for the teacher of the novice, and represent the state of the art in software engineering technology.

ACSE Volumes are employed as supplements to formal lectures, much as "wet labs" have traditionally been used to accompany lecture material. ACSE does not replace a traditional laboratory experience; the two are complimentary. ACSE Volumes are used to: familiarize the students with unusually complex developmental processes that require extensive four- dimensional visualization; expose students to important experiments that cannot practically be employed in an undergraduate laboratory, because of a need for sophisticated equipment, extensive training, excessive experiment durations, or dangerous reagents (such as radioactive probes); and allow students to make direct changes to the underlying scientific model realized as a program, and to see, through the execution of the program, the ramifications of those changes.

A prototype of the ACSE environment has been in use for one year by teachers, high school students and university students. Subjective feedback has been positive. Formal evaluation of the effectiveness of ACSE is forthcoming, and design and construction of the full-featured ACSE environment is in progress.

A COMPARATIVE STUDY OF EXPERIMENTAL APPROACHES TO HYPERMEDIA-BASED LEARNING IN FORMAL DOMAINS.

ALAN P. PARKES
Computing Department Lancaster University
Lancaster LA1 4YR UK
E-mail: app@uk.ac.lancs.comp

Keywords: hypermedia, learning, problem solving, formal domains

In formal domains, many problems can be solved more effectively if an appropriate representation is selected. In formal language theory, for example, several theorems related to regular languages can be understood more easily by casting them in terms of properties of the finite state recogniser (the abstract machine equivalent of the regular grammar). Moreover, it is often the case that the most suitable representation for solving a given problem may have a diagrammatic realisation. The finite state recogniser can be drawn as a directed graph, and the resulting representation can suggest properties of the language (repeated substrings in sentences, for example) which are not so obvious, either in the corresponding grammar, or in the textual transition function representation of the machine.

With hypermedia interfaces, we can take advantage of these alternative representations by actually presenting them in the interface. For example, in a previous study, we presented users with a (Hypercard) system in which the proof of a theorem of context free languages was carried out by applying simple direct manipulation activities (pointing and clicking, cutting and pasting) to a diagrammatic representation of a derivation tree. A related study involved users proving the same theorem by interacting with an interface in which two representations (the diagram, and a textual representation) "cooperated", in the sense that both representations were equivalent, either could be operated on as the user wished, and the results of operations carried out on either representation were immediately reflected in equivalent changes to both representations.

Interfaces of the above type are useful in that, for a given problem, they can present the learner with an appropriate representation (it is often difficult for learners of formal domains to decide just what is the most appropriate representation for a given problem). Moreover, such interfaces also enable steps in the problem solving process to be modelled as simple constrained direct manipulation operations. However, they essentially embody the "classic" hypermedia approach which can be found in other applications of hypermedia, such as information retrieval i.e. the environment is basically navigational.

Navigation is one way to explore an environment. An alternative way of exploring is to build things. For this alternative, constructive, approach we can use hypermedia to present parts of representations, expressed in full text, diagrams, and mathematical notations, or combinations of

these, which the user has to piece together in order to express a solution to a given problem. The goal for the user is expressed as an overall "picture" (not necessarily literally as a picture), and the "pieces" are designed so that they fit together to create a representation of this overall picture (which may be an annotated diagram, or a linked series of hypermedia states, in the case of a proof) in only one way. We call these interfaces "jigsaw interfaces".

We are carrying out a study of users interacting with jigsaw interfaces based on similar formal reasoning tasks to the theorem proving task of the studies referred to above. The study is investigating whether or not the actual process of putting together the pieces to make the overall "picture" is a useful aid to learning. In parallel, we are carrying out an additional study of the navigational approach described above, but in this case, the system is amended so that the theorem is initially described to the learner (and subsequently made available to the learner, on request, throughout the session). The task is then defined to the learner as explaining the meaning of his or her manipulations of the graphical representation in terms of the proof of the theorem (as opposed to trying to derive the theorem for themselves, as in the original studies). The reason for this change is to create a parity between the original system and the jigsaw interface for the same task i.e. both activities will have clearly defined goals. The two studies involve distinct groups of users with similar backgrounds and experience.

The conference presentation will focus on a comparative discussion of the two approaches (the navigational and the constructive) to problem solving and learning in hypermedia interfaces. In particular, the presentation will compare the nature of user explanations of meaning in the two types of interface. The relationship between the research described and other approaches to hypermedia learning environment design will also be discussed.

OBJECT-ORIENTED ARCHITECTURE OF MULTIMEDIA COMPUTER-AIDED LEARNING SYSTEM DESIGN TOOLS

VALERY PEKAR, VALERY RYZHUK
Institute of Cybernetics,
the Academy of Sciences of Ukraine
Kiev, Ukraine
pekar@eindex.kiev.ua

Design of multimedia computer-aided learning information systems requires a new tools because data items of different types are used, and it is necessary to attract specialists on particular domain to design process. Certain experience of development of these tools is accumulated during last years, and some general principles are more evident than some years ago. The paper attempts to formulate these principles and draw the general model of multimedia computer-aided learning information system architecture of certain class.

Software tools are being considered in the paper are ToolBook by Asymetrix for IBM PC, HyperCard for Macintosh, KeyAuthor for Archimede computer by Acorn, and MIM for IBM PC that is developed by presenters with colleagues in the Institute of Cybernetics of the Ukrainian Academy of Sciences. These tools have some characteristic features that allow to define them as representatives of a certain class of multimedia tools.

It is necessary to give some definitions to explain this point of view. We define information system as a set of software and hardware components intended for a storing, retrieving, updating and presenting the information to user on his inquiries. We say that information is multimedia (or presentation is multimedia) if its portions are oriented to different organs of feeling of human or to different forms of perception. Further, multimedia information system is an information system that outputs (and inputs) multimedia information. These definitions cover very wide class of systems including animation and business graphics. Therefore, we describe the model which selects systems we are interested in from other ones.

Let us introduce the set of data items U. (We mean that data items are of different types, i.e. multimedia.) Each data item $U[i]$ has several presentations $P[j](U[i])$. Let us define a view as a set of presentations $V = \{P[j_1](U[i_1]), ..., P[j_n](U[i_n])\}$. The set of possible user inquiries is denoted as Q. Then, we consider information systems that can be presented as functions Q-V.

Information systems designed by software tools that have been listed above can be considered using this model. Then, we can state that there are two general concepts that are very convenient for implementing this model. They are object-oriented model of data and event-oriented model of interface.

DATA MODEL. Let us define class as a data domain and a set of data manipulating functions $C[i] = D[i], \{P1[i],...,Pn[i]\}$, and domain of definition of all $Pj[i]$ is $D[i]$. We call Pj[i] as methods of $C[i]$. These methods can, of course, be parametrized, i.e. $Pj[i](d, p_1, ..., p_m)$, where d is of $D[i]$, $p_1,...,p_m$ are of certain (basic) sets (for example, numeric or string). We say that C[k] inherits $C[i]$ if some of $Pj[k]$ are the same as $Pj[i]$, some of them are redefined and the rest is new (not presented in $C[i]$). In this case we call $C[i]$ as ancestor, $C[k]$ as descendant. There is a tree of classes if only single inheritance is implemented (only one ancestor for every class), and a graph if multiple inheritance is implemented (more than one ancestor). Returning to the information systems problem, we note that some of $Pj[i]$ are presentations in the above mentioned meaning (other ones can be, for example, update or transformation functions). Then, a view V is a set of methods performed $\{Pj1[i1](d1,...),...,Pjn[in](dn,...)\}$where ellipsis denote other parameters p_1, ...,p_m. Thus, the smallest action that can be performed in a system is the call of method $Pj[i]$ of class $C[i]$ with the data item d and parameters $p_1,...,p_m$. We denote the set of such calls $Pj[i](d,p_1,...,p_m)$ as T.

INTERFACE MODEL. Let us introduce query set Q consists of possible user queries or, more general, user actions. Each query generates an event from event set E or a sequence of events. In particular implementation E consists of key pressing events, mouse events, timer events etc. The

user-system interaction can be presented as the sequence of events and system answers. At this point of view, we give that information system of class being considered is a function $F(e)=(t_1,...,t_n)$ where $t_1,...t_n$ are of set T.

This is the most general model of wide class of computer-aided learning information systems. Then, we can define a set of requirements to design tools which implements this model. These tools should:

- Create new data class determined by its methods.
- Attach new data manipulation and presentation functions as methods of class.
- Create new class as a descendant of existing one, redefine old methods and define new ones.
- Allow to parametrize methods.
- Create and edit information system definition as a function E-T.

There are different techniques of presentation and editing of this function. Existing tools use graph representation, specific language, hypertext representation etc. The MIM integrated environment designed by presenters uses table representation that is described in the paper.

COMPUTER-ASSISTED LESSON WITH THE PATTERNS OF REFERENCE SIGNALS AS A TEACHING HYPERMEDIA

TAMARA N. PODDUBNAJA, IRINA I. FUCHS
Tomsk State University, Informatic's Department
86b, Kievskaja str. #16, Tomsk, 634012, Russia

Keywords: reference signal, computer graphics, cognitive function, theory of step-by-step forming of intellectual actions, computer-assisted lesson

A quality of any teaching system greatly depends on how efficiently the details of knowledge perception process were taken into account. This is also true for the student's information processing in any form including graphics.

A computer graphics - one of the most important components of the new information technologies, fulfill two main functions. An illustrative function, that facilitates visual perception of a matter studied, is fulfilled by usage of static and dynamic models, representing some characteristics of the material. In the psychological and pedagogical sciences and their applications, the cognitive function of graphic images is considered as an important means of activating human abilities to extract a new information at a non-verbal level. One of the brightest examples of purposeful usage of the cognitive function of images is representation of a studied information in a form of systematically structured coded schemes, or, as V.F.Shatalov put it, the patterns of reference signals. Essential content, in this case, is only denoted by a symbol presented in the pattern, it is "hided behind" the symbol, and may be connected with it by association only. This gives a reason to another name for the schemes - "denotation cards".

Detection of a subject content and its absorbing demand in this case certain efforts on the disclosure of a concrete subject meaning of a graphic image given, because in itself it can hardly to create an adequate knowledge in pupil. Images that facilitate the cognitive function of a pattern of the reference signals, - are either well-known professional symbols or tables, graphs, schemes, drawings, abbreviations, standard and associative elements. They can be considered as symbolic sign models of the teached information. Joint in a single structure that represents interconnections between denotations, these models are widely known in pedagogical psychology schemes of reference point for thought forming. It is an active tool for organization of leaning process. The illustra-

tive function of the scheme is growing in the process of gaining knowledge represented by the scheme, especially in systemic and structural aspects of the knowledge.

The organization of leaning process with usage of patterns of activity reference point - is the central item of theory of information adoption, that was named by P.Ja.Gal'perin a theory of step-by-step forming of intellectual actions. In addition to definite ways of forming and displaying schemes of referent points, this theory clearly defines types of tasks to be learned and psychologically recommended order of steps in adoption of studied information. All that enables us to use this theory as a foundation of pedagogical planning of learning activities (N.F.Talysina) and of creating computer-assisted lessons and courses.

First special feature of such courses is stressing a role of patterns of supporting signals as milestones in leaning activity. Such an organization of student's work, with all pedagogical conditions, can be made with the help of multi-window interface.

Second special feature of a computer-assisted course is that it contains a compulsory information on deciphering of coded images into a subject content. Ideally, this information has to be presented as a special semantic network, an external materialization of which is the pattern of reference signals.

Computer-assisted lesson is a certain sequence of frames ("pages", "cadres"). The sequence may be rigid, strictly following leaning strategy defined by a teacher. Another possibility is to make it flexible, adapting to personal style and abilities of a student. In both cases a student is supposed to work with various types of information (in textual, graphic and other dialogues). The abovedescribed ideas are embodied in a computer-assisted lesson on theory of sets.

THE ANIMATOR OF VIDEO-TEXT IMAGES

V. RYNGATCH, O. CHIORSAC
Department of Mathematic and Cybernetics, State University of Moldova

Keywords: toolkit software, video-text image, video-effects, animated films, procedures and functions.

The animator of video-text images is the toolkit means which is intended for making static and dynamic pictures with the reproduction purpose in the teaching, displaying, advertising and some other programs written in the high level languages.

It gives the following possibilities:

- To create and edit the files of static representations in text mode which consist of any ASCII-characters of different colors at different backgrounds with blinking letters and unblinking ones with ordinary or high brightness.
- To separate the image as a block one and to move it on the screen with writing its trajectory for further animating of the block in reproduction of the image.
- To shoot the animated cartoon films with participation of up to ten block-images as actors. During the distribution of the roles, i.e. separating the blocks, they are given the number of plan. In crossing the objects during the animation of the film, the objects with the smaller number settle on the background and with the larger number - on the front-ground, hiding each other.
- To copy the created by any other programs screen image in order to animate and include it in your program. For copying the screen image the resident program-scanner is used.

Created static and dynamic images can fill any program of user with necessary video-effects. For it, the package of necessary procedures and functions exists in the following languages: Turbo C, C++, Turbo Pascal.

The requirements to the equipment and software environment: the complete IBM compatibility on the level of DOS and BIOS; videoadapter CGA, EGA and any other one which has four pages of video-memory with the segment address HEX B800; DOS 3.30 and higher.

NAVIGATION IN A VIRTUAL LIBRARY : INFORMATION ORGANISATION IN A CD-ROM ENCYCLOPAEDIA

S.C. SCARBOROUGH; T.J. BRAILSFORD & P.M.C. DAVIES
Bio-informatics Research Group, Department of Life Science,
University of Nottingham, UK
TIM_BRAILSFORD@UK.AC.NOTTINGHAM.VME

Keywords: CD-ROM, Encyclopaedia, Hypermedia, Telclass, Concept Classification.

One of the greatest benefits of using optical storage technology to provide an educational resource-base is the vast capacity of the media. This however also causes one of the most challenging problems in this field, that is how to organise such quantities of information in a manner that is both flexible enough to meet stringent user requirements, and yet remains easy to use. A CD encyclopaedia can typically contain the equivalent of many printed volumes of text, thousands of still images and hundreds of animations and media clips. The majority of these encyclopaedias are navigated by means of a relatively simple menu based index, coupled with a word search facility and sometimes keyword searching and hypertext linking. Although this approach is quite suitable for casual browsing, the volume of information available can easily become overwhelming. It can also be difficult to find specific information if the users only have vague ideas about what they are looking for.

In this paper we describe how these problems have been faced in the design and continuing development of the Multimedia Encyclopedia of Mammalian Biology (MEMB). This is a joint development between ourselves, McGraw-Hill, Attica Cybernetics, and the British Broadcasting Corporation (BBC). In MEMB we have made extensive use of an intelligent navigation system that is based on the Telclass(TM) system developed by the BBC TV Library Services. This involves a hierarchical concept classification that allows the user to browse and search though the information using taxonomic, biogeographic, or thematic concepts as well as a more conventional book structure.

The basic units of information in the encyclopaedia are nodes that are visited by users as they browse and search. Nodes are clusters of interrelated resources (ie text, photographs, drawings, sounds or movies) that are united by their relation to a single focal concept. This concept may be an animal such as a "cheetah", a habitat such as "grassland" or a broader concept such as "running", or "carnivory". All of the resources that comprise the encyclopaedia are likely to appear in a large number of nodes. Thus a movie clip of a cheetah chasing a wildebeest could appear in any of the above nodes. In order to make the encyclopaedia navigable these nodes are linked to one another by an enormous network of semantic links that underlies the entire information system. These links may be either intrinsic using an automated system based upon Telclass or extrinsic in a more conventional hypertext manner.

Telclass is an hierarchical system of concept classification that is in many respects similar to the library duodecimal system of subject classification, but has far more depth and flexibility. One of conceptual hierarchies that we have used in MEMB is that of biological taxonomy, and this serves well to illustrate the principles of Telclass. A conventional word search for the word "CAT" would not find the word "CHEETAH", but it is found using Telclass because cheetah is a daughter concept of cat. Thus in our example of the running cheetah there will be intrinsic links to other nodes on cheetahs and at a higher level to nodes on leopards. The "cheetah" node is also linked to nodes on "grassland" in the same way because cheetahs live in grassland habitats, and to "running" because they can run faster than any other land animal. In its turn, "grassland" is linked to "wildebeest", and both of these have links to "East Africa".

Thus MEMB consists of a large collection of nodes connected by a network of concepts and intrinsic links. This results in the search and retrieval system being more "intelligent" and "efficient" than is usually the case because its operations do not depend entirely on keyword matching. This is underpinned by a system thesaurus that contains the concept hierarchies, and by browsers that are derived from this and are available to the users. There are four browsers - the book browser (ie a conventional table of contents), the taxonomic browser (containing the formal biological classification), the biogeographic browser (containing geographical and habitat concepts) and the thematic browser (which contains broader concepts such as "running" or "carnivory").

SOME ASPECTS OF MULTIMEDIA TUTORING SYSTEM DESIGN

VLADIMIR V.ZADOROZHNY

V.Glushkov Institute of Cybernetics, Ukrainian Academy of Sciences
40, Prospect Akademika Glushkova, 252207, Kiev, Ukraine

The modern achievements of personal computing, possibilities to manipulate with information of different types (video and audio fragments, text, graphics, sound, knowledge etc.) call forth the necessary of design of tutoring systems using multimedia technology. However, present techniques of tutoring system design are oriented to usage of conventional forms of presentation of source information: texts, numbers, boolean values. Therefore the problem of development of techniques and software tools for multimedia tutoring system design is of present interest.

Every computer-based tutoring system can be considered as composition of three components: subject conceptual model, student model and tutoring techniques. The approach to design of these components when multimedia information is used are considered in this paper.

SUBJECT MODEL. The knowledge on the subject being learned is usually represented by the notion graph, its nodes represent notion descriptions, and links represent their relations. Nodes can be represented by frames with slots which describe used notions. Slots are of following types:

1. Set of "attribute — value" pairs, i.e. there is a finite set of features, every feature has a set of admissible values M_i.

2. Data associated with introduced notion (video and audio fragments, graphics, texts, tables etc.).

Denote the graph of subject conceptual model as $G(T, V)$. The process of this graph building for real tutoring courses is, as a rule, very hard and weakly formalized stage of tutoring course design. More, the quality of course being developed depends substantially on the level of adequacy of this graph to the subject. Further, this graph consists of a great number of nodes and links for most application and, in fact, can not be used in practice. Therefore it is necessary to pick out the set of base notions, i.e. the minimal set of notions that is, in some sense, completely represents the whole subject graph.

The formal description of this problem, analysis and algorithm of solving are described in the paper.

Let us introduce some necessary definitions.

Let us call as the neighborhood of vertex $t \in T$ the set $\widetilde{K}_t \subseteq T$ such that for any vertex $t' \in \widetilde{K}_t$ one of two pairs (t,t') and (t',t) belongs to set V.

Let us call as the covering of set T by the system of notion P the set of vertices $K \subseteq T$ such that $T = P \cup \bigcup_{t \in P} \widetilde{K}_t$.

Let us call as the set of base notion the covering P^* of set T if $P^* \subseteq P$ for all coverings P.

Linear order on the P can be introduced by one of known methods.

Now the problem can be formulated as following. Let us $G(T, V)$ is the subject graph with the set of notions T and set of links V. There is necessary to pick out $P \subseteq T$ such that P is the covering of T and $P \leq P^*$ for any covering P^*.

There is shown that this problem is NP-full, and the convergent to the exact solution algorithm is stated.

STUDENT MODEL. The student model is considered as the set of vectors of varying length $\tilde{P} = (P_1, \ldots, P_{|T|})$, i.e. there is a vector P_i corresponding to any vertex of graph $G(T,V)$. Vector's coordinates have the following sense:

- Mark of quality of exercise done.
- Kinds of student's mistakes.
- Level of mastering of previous themes.
- Complexity of current exercise.

TUTORING TECHNIQUES. The tutoring techniques in the computer-based tutoring systems is the function that yield the next tutoring influence basing on the current state of student model. In other words, the tutoring techniques is the strategy of girth of subject graph.

Let us consider the function F defined on pairs (T,P_t) where $t \in T$, $P_t \in \tilde{P}$, and having the set T as the domain of definition.

F can be represented by following algorithm. On the first stage the some strategy of girth of graph is fixed, for example, top-down. On the every transition to new vertex student choose the new vertex himself or it is chosen automatically by solving a problem of pattern recognition as the statistics of tutoring is accumulated.

PREJUDICE AND DIDACTIC APPLICATIONS BY MEANS OF COMPUTER MEDIATED COMMUNICATIONS

AVINOAM BEN ZEEV , MATZI ELIAHU
Haifa University, Oranim - School of Education,
UniversityDivision
Tivon 36910 ISRAEL
E-mail: RHPH301@HAIFAUVM or TTRO142@TECHNION.TECHNION.AC.IL

The lecture will present the complex concept of a course conducted in three stages, integrating frontal academic teaching with the processes of communication between teachers-in-training and secondary school pupils. The presentation will discuss advantages and difficulties which arise in such a complex teaching arrangement, even though the course is focused on a specific subject such as prejudice.

The Purpose of the Course

A basic assumption of the course is that it is possible to minimize the influence of prejudices when individuals are made more aware of their own prejudices and those of others. The course presents the problem and its extent, points out specific prejudices, and suggests ways of dealing with prejudice both individually and in groups through the use of computer mediated communications.

The Structure of the Course

Each Oranim Teachers College student takes part in the project by telecommunicating with three secondary school pupils from three different schools. The secondary schools are located in different areas of Israel. The students guide their pupils under the direction of two instructors at Oranim. The school teachers whose pupils participate in the project also meet with the instructors at Oranim to learn the subject matter of the course in order to be able to follow the communications between the students and their pupils. Parallel to the structured part of the communications (based on exercises taken from the course text), the students are expected to encourage their pupils to communicate among themselves on the subject of the course.

The Procedure of the Course

The course is based on individual and group tasks which the students send to their pupils. The sequence of the exercises given is determined by the order of discussion of topics. All theoretical content is presented and discussed by means of at least one exercise. The whole series of exercises is intended to present a complete theoretical picture of the subject. Some of the exercises are given simultaneously to all pupils participating in the project. Other exercises are given according to the preferences of the individual Oranim students, who can choose from among the various exercises which deal with the same topic. The exercises which are given simultaneously to all pupils provide data of research importance for reaching more general conclusions through the use of computer tools (data base and spreadsheet) which are also presented as part of the course.

Advantages and Difficulties

Throughout the course the students are encouraged to derive benefits made possible by computer mediated communications in open learning connections (taking advantage of the informal situation in the teacher-student relationship), free-form (taking advantage of the physical distance between teacher and pupil), flexible (utilizing various tools available on computer), personalized (exercises and responses given individually to each pupil), and unexpected (the learning is based on a continuous process of discovery).

The main difficulties in management of the course arise from technical problems such as breakdowns in network communication and difficulties in maintaining uninterrupted communications between students and their pupils.

PRACTICAL TELECOM FOR EDUCATION

DIANA BOGDANOVA, ANDREI FEDOSEYEV
Institute for Informatics Problems
of Russia Federation Academy of Sciences (IPIAN)
30/6, Vavilova, Moscow, 117900 Russia
E-mail: almanac%adonis@sovam.com

Keywords: telecommunication, electronic mail, education project, distant learning, databases

As technical and financial problems of getting an access to e-mail are being solved, new problems have appeared - methodological ones: what are the most efficient ways of using e-mail? Several types of telecom activity could be analized: a project work, distant learning and using distant databases.

To begin a project work it's not enough to get a modem and become a customer of one of telecommunication systems. One should either have a partner to discuss and to create mutual projects or to join an education system or a centre which leads education projects.

We consider it very important to know how to create education projects. A method of education project designing was developed at IPIAN with the use of some scandinavian materials. Then a teacher training course was created. Every teacher having taken part in the course gets the idea of what an education project is, knows how to develop and to run education projects, remembers outfits of plenty of projects and has his/her own project being developed during the course.

Two other mentioned above telecom possibilities cannot be in nowadays practical usage. The idea of distant learning demands comparatively large number of possible users of on-line teleconference system. The use of distant data bases demands data bases existence. Untill there are no education data bases distant usage of them is out of practice. But the situation with telecom services changes very rapidly so we should be ready to use these types of telecommunication as well.

Distant learning is a very efficient and important type of education activity in such a great country as Russia. To deliver a course via a telecom system one should take into account that:

- The course must be designed in a special way,
- The course leaders must have moderator skills.

Trying to create education data bases we should remember that telecom access is not cheap now. Besides we cannot expect more then one access to a telecom system from every school. So the database content should be of such a nature that every reference can be of use for many students in a school.

Leading an active telecom education centre for three years authors represent a group of specialists which is ready to develop regional education telecom centres supplied with special software and methodical materials. Two pieces of software being developed to support telecom activity is presented for demonstration. They are:

- Multy language word processor combined with a coding system to get messages written in different alphabets transferable via any telecom system;
- 'Post Office' system in the support of telecom project co-ordinator activity: making links, co-ordinating school work, pressing lazy partners etc. The software can be usefull for organising an e-mail access in a school.

PROBLEMS OF USING E-MAIL IN EDUCATION

ALEXANDER DENISENKO
Ukrainian Phys-Math Lyceum, Kiev, Ukraine
E-mail: aden%teremschool.kiev.ua@ussr.eu.net

Changes of the political situation in the world and the increase of technical progress and information of a society is certainly having an impact upon the educational process of schooling. It is true, though, any system of education is a conservative system in its basis.

For the first reason because the system teaches ideas that are out-of-date. And secondly, because the people who teach these ideas studied in such schools themselves.

An overwhelming majority of teachers are sure that such a system as this is the most tested and proved, therefore it is insured from failure. Meanwhile the decreasing interest of youth in an education is a highly widespread phenomenon.

It is caused by the rapid development of scientific and social progress over one's system of education.

Telematics is now making its first steps into education. There are attempts of teaching it is a subject and using it as a tool for preparing subjects in the existing educational process. One makes attempts to use the means of telematics in the existing educational technology, that is to pour a new wine into old wineskins.

Insignificant advantages and significant expenses make telematics unfavorable in conditions of our present conservative system of education. In order for telematics to become effective in the educational process, we need to use technologies which give good results. Unfortunately this is unreachable for our usual educational process.

INTRODUCTION

Looking back, we certainly can see that the level of the cognition of the human society is developed along a broken line and approaches an inverse logarithmic dependence. The more humanity arises in its development, the more the system of education undergoes cardinal transformations. Turning, or critical points appear as a result of global changes, such as changes of formations and political intentions. The new needs required in a society inevitably are rejected by the system of education.

It looks like humanity is approaching the next turning point. The global opposition has ended. The preconditions for new interrelations in a human society appear.

The approachment of nations and the development of the human as a person are their main signs.

The existing national systems of education, similar in context but slightly different in form, are undergoing a crisis. The appearance of this crisis is caused by the level of social conscience that has arisen, but the schools are confined to solving usual, daily problems and ceases to grow with it.

Political opposition of systems causes schools no longer develop a man as a person but teaches a nationalism which would cause its people to protect itself and overcome the opposing system. All schools have solved this problem quite well and independently from the "Degree of Democratization" of a society.

All attributes, beginning with the rising of a flag and marching in line were inherent in every national system to some degree. The attributes tied together the different aspects of school life.

When opposition ends each society feels the necessity of changing the basis of the educational system in form and context.

Unfortunately, the steps taken shows that this motion is more intuitive than realized. Meanwhile the existence of new technology in the form of electronic communication, forms an alternative educational system of a new type on which the basis is of collective intellect.

For this purpose we should not build upon the old system of education with new computer technologies but instead explore new criteria to develop children's interests in all types of study.

It is very important that systems collaborate on an international level apart from stereotypes. As a result, a new understanding between nations will appear that will be useful in creating a new educational process.

Practical work in international telecommunicational projects,such as "Starts Schools", "Global laboratories", and "European Schools Projects" allows to evaluate perspective directions of developing telecommunication for education,namely - teletrips and teleconferences.

TELETRIPS

Teletrips, as an educational process, are widely used in ESP (Herk Scigte, *Telematics in Dutch Education Experiences from the Classroom*).

They are designed jointly by teachers from different countries around a part of the educational process.

Conditionally, teletrips can be divided into 3 categories according to the duration of an action of each project.

The first category is short and very short. They, as a rule, are devoted to some events,which spontaneously appear and rapidly disappear. The short duration of teletrips can be caused by:

- Actuality of an event for a current moment.
- The absence of the subject in discussion in lengthy dialogue.
- Tests which cannot be analyzed.

As a rule, short dialogues are not fruitful. Questions about what you have eaten for breakfast or how many brothers and sisters you have usually do not require answers. Such dialogues are acceptable only for immediate dialogues face-to-face. One sees the reaction of another and dependently on this he either continues or changes the subject. So far, electronic mail is not able to transmit feelings, therefore dialogues cannot be in a completed form.

Dialogues devoted to some events or anniversaries can give a push for more lengthy mutual study. For example it can boost the creativity of poets. Advantages of conducting dialogues in foreign languages is obvious, but often it causes difficulties and is the main reason of ceasing dialogues. Because of this, sometimes it is useful to compromise by giving the opportunity to send all materials in the native language to every partner. It allows to keep the main subject.

Teletrips of medium duration,the second category,are planned for a part or whole year of study. They are usually oriented on basic educational processes,which require great enthusiasm from teachers and students. An exception is linguistic projects,in which the texts of a partner is used as an exercise for translation,which would contain information.

Projects which duplicate usual , school courses are doomed to die. It can be observed from statistics given in the literature.

Using boring and tiring subjects for discussions are problems but not the only problems. Although e-mail allows the quick exchange of information, in practice,restrictions appear which result in irregular exchange.

Within the medium level there exists an abstract value,which measures the interest in projects.The second problem appears with the presence of impulsive processes,which cause this value to decrease proportionately with the increase of time of intervals between messages.As interest in the project decreases,the impulsive processes,in turn,decrease.Thus,the entire process is terminated.

The third important problem is the absence of statistics in subjects and in the analysis of projects which are in action, which is true within systems I have had experiences with. An analysis is necessary in order to evaluate the perspectiveness or non-perspectiveness of projects.Under-

taken,so that errors will not be repeated from previous projects. As a result of the first two types of teletrips,a third appears which is longtime projects. These projects are rich in content and ',as a rule,will have a deeper study of problems.Such teletrips exist between (name) in Germany and (name) in Ukraine. Students of both schools participate in this project,Project Aquadata,and work on problems of ecology. In particular,one of their problems is determining the quality of water in the rivers Dnipro and Rhine. Students of *PASCAL-GYMNASIUM,GERMAN* use chemical methods of analysis and students of Ukrainian Physical Mathematical Lyceum use physical ones.

These mutual researches ,which is an exchange of methods and of results of researches,mutually add to each other and make the collaboration mutually beneficial. This project is not confined by terms and children of all ages can participate in it. It provides for the development of collecting results and getting more reliable information, as well as finding new problems to solve.Such projects create a precedent for highly quality,new type of collaboration,in which students, prospective specialists, of schools,live by the same problems find contacts and mutual understanding. At the same time,this collaboration is an alternative system of education. As well as in usual schools, the work on a project requires knowledges in physics, chemistry, biology and geography. They receive this from books, from teachers,and mainly from one another. The experience of working in such groups shows that in these cases the speed of mastering the material increases exponentially. Uniting children of different ages in one group also has a favorable affect. Older children,who have more knowledge,desire to hold their position of leadership in their knowledge to better themselves all the more. The others try to approach the level of leaders and absorb all information like a sponge. An aspect of competition and awareness of one's own significance will satisfy the problems of a child's vanity.

THE VIRTUAL CLASSROOM: USING TELEMATICS FOR DISTANCE LEARNING

B. J. GLEASON & RICK GIBSON
Computer Science and Information Systems Department
The American University,4400 Massachusetts Avenue
Clark Hall #124 Washington D.C. 20016
E-mail: rg4124a@american.edu

Keywords: virtual classroom, telematics, distance learning

Like many other educational practices, lecture-based instructional methods remain unstated, unexamined and unacknowledged unless challenged from the outside. One such challenge is the increasing use of a combination of computers and telecommunications to permit distance learning and ultimately, to enable the creation of a time- and place-independent virtual classroom. As Elmore (1991) observes, the unparalleled opportunities for learning via the convergence of video, audio, data and print technologies forces educators to reconsider traditional educational patterns. This convergence of technologies has been labelled "telematics," a concatenation, of French origin, of the terms telecommunications and informatics.

Clearly distinct in design and purpose from a computer laboratory, the purpose of the virtual classroom is to use telematics technology to revolutionize learning. For some time now, the use of computers in the classroom has been increasing due to information technology advances and attainment of computer literacy by instructors in a variety of disciplines. Lyman (1988) describes computing as only the second technical innovation in education, the first being educational television—a technically promising medium implemented in a manner that merely reinforced the traditional pedagogic relationship with "talking heads" lecturing to "virtual classrooms" of students at more convenient times and places. Sophisticated audio/video presentations certainly improve the quantity and diversity of the information offered, but its flow remains unidirectional, from the instructor to the student. Conversely, telematics has the inherent capability to change teaching and to empower learners.

Mizell (1989) explains that the use of technology to educate learners located some distance from the traditional school campus has acquired a variety of labels ranging from "on-line education" to "open education," with some recent consensus on the term "distance learning." In many parts of the world, distance learning has developed in accordance with national educational policy and is often centered around a single institution. In the United States, the pattern of distance learning has emerged in a wide variety of settings and curricula. Miller (1989) attributes this diversity to a Constitutional prohibition of the Federal government taking a direct role in education. As a result, distance learning has come to be seen as a technical issue embedded within existing educational institutions. Diverse activities including correspondence courses, interactive television, satellite teleconferencing, audio graphics, electronic mail, computer conferencing and computer-based instruction are all accepted as distance leaning activities. Moreover, distance learning is administratively housed as part of continuing education, within the domain of non-traditional instruction. Telematics, by enabling the virtual classroom, suggests the possibility of a paradigm shift in higher education in general and distance learning in particular.

Gleason (1989) identified three possible modes of delivery for the virtual classroom: virtual laboratory, mixed mode and totally on-line. Mixed mode can supplement instructional delivery with video and computer-based-instruction. However, within the context of a virtual classroom for distance learning, the totally on-line is the required mode of delivery. In this mode, all lectures and assignments are presented via a computer-based conferencing system. Perhaps the most important characteristic of the virtual classroom is that all students are empowered to participate, including those who are physically handicapped, geographically dispersed, and foreign students who are often not yet confident with their verbal skills. Furthermore, the option of anonymity results in questions and comments that would never arise otherwise due to peer pressures or other fears. Clearly, this new telematics channel surpasses the traditional oral channel and offers a prescription for richer learning experiences.

This paper will report, in detail, on our experiences with a variety of distance learning techniques and discuss the role and impact of telematics on the virtual classroom paradigm. Solutions to the associated problems of course preparation, software development and instructor training will be addressed.

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DEVELOPING MULTIMEDIA LEARNING ENVIRONMENTS FOR DISTANCE TEACHING

J.M. GREENBERG
Academic Computing Service
The Open University Walton Hall
Milton Keynes MK7 6AA
E-mail: J.GREENBERG@UK.AC.OPEN

Keywords: distance education, educational multimedia

The Open University has been a multimedia institution since its inception, and a range of media has been used to deliver educational materials to students. Course teams have attempted to integrate this media within their courses by developing study plans for students to follow. Multimedia technology offers the integration of some or all of the media types currently used by the University within a student workstation.

The new multimedia technologies which are emerging are backed by the major computer corporations such as Sony, Intel, Philips, Apple and Microsoft. A considerable investment has already been made by software developers in producing applications in the fields of training, sales, entertainment and education.

A number of projects are underway in the University which intend to exploit these new technologies for the benefit of Open University students. All of them will result in multimedia learning environments within which students will be able to access their course materials. Two particular projects will be described in detail in the paper.

One project sets out to restructure and present a section of the University's introduction course in Technology on CD-ROM. After evaluation in field trials, a second stage will seek to develop the entire course in this way. The project will be run as a pilot study in the first instance and seek to:

- Deliver a full version of all the teaching material, modified and restructured for screen presentation and stored on CD-ROM.
- Provide a documented account of the pedagogical and technical problems involved in restructuring existing teaching materials for CD-ROM presentation.
- Provide an assessment of the costs and savings of a CD-ROM based presentation.
- Evaluate the educational advantages and disadvantages of a CD-ROM based presentation.

A second project is intended to investigate the viability of multimedia as a distance teaching medium for undergraduate courses. It is based on the teaching materials from A295 Homer: Poetry and Society. This course was conceived as a highly integrated course in which video, audio and print would work together in a complimentary way. The project hopes to establish that multimedia enhances the freedom with which students can move around the course material. It intends to develop one of the course Learning Guides into a multimedia presentation in the first year and then, resources permitting, develop all other appropriate sections of the course in this way. The project will be run as a pilot study in the first year and be expanded in subsequent years. Apart from delivering multimedia material, the project has two strands:

- Investigate production issues associated with multimedia developments
- Investigate presentation and educational issues which the project raises

If the University wishes to exploit the potential of multimedia technologies in its long term teaching strategy, it must provide the infrastructure to support its development. Such development can be carried out with the knowledge that by the end of the decade, these technologies could well form part of the University's home computing equipment specification for the first decade of the next century.

The success of multimedia applications depends entirely on educational imagination and the academic ideas behind the application. We may require new educational ideas just to teach our Academic staff about the potential of multimedia and how to develop Open University courses around it.

COMPUTER MANAGED LEARNING, DEVELOPMENT

ZHU YUN GU, NORM WATERS
Technology Management Centre
Elgar Road Campus, Deakin University,
221 Burwood Highway, Burwood 3125
Victoria, Australia
E-mail: guac@brt.deakin.edu.au

Keywords: computer managed learning (CML), DOS, VAX/VMS

Introduction of CML

The Computer Managed Learning (CML) system is a computer based system, which was developed by CBTS, Ltd a Campus America Inc company and is distributed in Australia by CBTS (Australia) Limited and widely used in Australian Universities, TAFE Colleges, Secondary Colleges and Industry.

CML is designed as an instructional development, delivery and evaluation tool to assist in the management of learning. It offers a comprehensive set of programs to support a variety of learning environments.

The CML software runs on a VAX/VMS system and is menu driven. It can be used for inhouse testing, on-line or paper based and also in a distance delivery mode, problems with the latter being the reason for this development.

Students and Instructors who use the system for distant learning gain access to the VAX, CML system via a modem and using a communication package called Procomm. They are then able to down-load CML files from the VAX to their PCs' hard disk via Procomm.

Introduction to Technology Management Centre

Our centre, Technology Management Centre (TMC) is attached to the Faculty of Science and Technology, Deakin University, Victoria, Australia. We have developed self-paced courses for people seeking to improve knowledge and gain qualifications while working in manufacturing and service areas. Using this mode of delivery together with self-paced notes they are able to study within their own time lines either at home or at their workplace. Students use Email to communicate with Tutors.

Need for the development

However, we found some limitations with the CML software when students are using the system in a distant learning mode. Students are required to hit the return key for each screen to be able to extract the CML exam file. This was neither practical nor efficient. The CML system has limited options to allow for the development of site based functions. Therefore there was the need for development to take place to enhance our method of delivery to students.

Methodology for the development

It has been identified that the CML exam file can be extracted when sent to a defined print queue. We undertook two methods of development which involved the VAX/VMS side and the DOS side.

We approached the VAX/VMS side by taking the following steps:

- Dummy print queue is created and is cleared regularly.
- Corresponding VAX/VMS files are edited for our needs.
- The CML menu is updated correspondingly.

Students can now extract their CML files by taking the following steps:

- Logon to VAX/CML as before to draw down a test or access other functions.
- Copy the exam file across from the CML directory to their own directory.
- Logout of CML but not the VAX.
- Download the exam file from VAX to their hard disk.

This process was found to be rather complex for students, so we undertook development from the DOS aspect.

From the DOS aspect:

- CML sends the exam file to the printer port where it is interpreted and redirected to a file by a shareware prn2file.com.
- Printing files are appended in one file, this file is separated by a designed cmlprint.com when students logout from VAX and return to the DOS prompt.
- After the separations, the file names are given and saved under DOS.

The strategy for designing the cmlprint.com is pattern matches. It:

- Automatically scans the extracted file.
- Recognises the breaks between different files within the extracted file.
- Names the generated files in terms of their module names and other parameters, so the file name is unique.

The DOS approach can be simply implemented by setting up a batch file in DOS that installs two major programs: prn2file.com and cmlprint.com to the right directory.

Conclusion

This development will benefit all CML users. It has been trialled with a group of students for over a month and the feedback has all been positive at this stage. It is invisaged that the remaining of our five hundred students will be given access within the next six weeks.

ANALYSIS OF MEANS FOR SOLVING A PROBLEM OF CREATION THE MILITARY EDUCATION SYSTEM INTEGRATED COMPUTER NETWORK

ANDREY IVASHCHENKO, ANDREY ZHUKOV
Military Education Department
Ministry of Defense of Ukraine

Keywords: computerization of education system, educational institutions computer network, educational system integrated computer network project, coordination center, regional center, distributed data bank.

Military education system which is being created in Ukraine encompasses Ukrainian Armed Forces War College, Military University, 7 military institutes, 8 military departments (faculties) and a number of military training chairs organic to civilian higher educational institutions, 9 military lyceums.

Creation of such an education system aimed at the training of specialists meeting modern requirements, forthcoming development of science and of administrative system is impossible without solving problem of computerization and introduction of computer-aided information processing technologies.

Computerization of education system seems to be a process of developing and wide application of information resource in education, scientific research work and administrative activity using modern computer technologies and computer networks.

Military Education Department has worked out a Concept of education system computerization. In accordance with this concept solving of computerization problem is to be aided by information resource development, creation of distributed data banks, multiuser data banks, local area networks and their integration into education system computer network.

The purpose of the Concept's realization is to work out new information processing technologies in education, science and administration, which makes it possible to:

- Develop information resource required for education, scientific research and administrative activity.
- Introduce new training methods that amplify creative thinking during education, scientific research, training and refresher courses.
- Employ modern administrative methods.

Thus there are two main directions in education system computerization Concept:

- Development of information resource.
- Creation of Education System Integrated Computer Network (ESICN).

The Coordination Council on Development and Realization of the Concept and the Program of Education System computerization attached to the Military Education Department has been founded in order to coordinate activity of higher educational institutions and other parties concerned.

To render financial support to the Concept and the Program Coordination Council is about to found a Fund for Support of Education System Computerization (FSESC).

To unite effort of educational institutions to create information resource on region level, computer users and information processing technologies specialists training, running the ESICN, the Educational Information Processing Technologies Coordination Center (EIPTCC) is being founded in Kiev. This Center is to be complemented by system of Regional Centers (RC) throughout Ukraine. There will be only 5 RCs at the first stage (Lvov, Kiev, Kharkov, Odessa, Sebastopol). At the following stages 3 more RCs will be organized (Kamenets- Podolsky, Dnepropetrovsk, Donetsk).

The EIPTCC and RC will also perform gathering, processing and storing of information on educational and scientific topics, software development and distribution, higher educational institutions being the main consumers of software.

Global network project based on optical-fibre channels, satellite communications can not come true because of it's extremely high prices. Hence the only suitable solution is to use means of communication, hardware and software available nowadays.

ESICN project is based on the Open System Interconnection (OSI), Technical and Office Protocol (TOP) which have been adopted by OSI, on the IBM System Network Architecture (SNA), X.25, X.75, X.400, X.500 recommendations and "Information processing technologies" USSR Standards.

The ESICN encompasses EIPTCCs and RCs mentioned above. The rest of higher educational institutions join it as users.

RC as well as the whole ESICN will provide "star" network configuration, but RCs will normally communicate not only with the Coordination Center but with each other as well. RC provides regional data base management, users' access to data banks, transfers regional information to the Coordination Center and executes queries of other RCs to regional data base. Information owners must periodically update information in RC's data base. Users interact with the ESICN as remote work stations.

Such a configuration of the ESICN will provide

- Maximum number of possible information transfer directions.
- Promptitude of access to information.
- High system reliability.
- Minimum communication costs.

Network hardware must be bought by educational institutions or supplied with Military Education Department's and FSESC's assistance.

Creation of the ESICN suppose availability of data bank administration software. Special purpose software must be distributed by EIPTCC.

Working network segment must be available at the first stage of the Concept realization.

To provide that distributed data bank prototype supporting wide range of users and information owners, having easy-to-use user interface and providing on-line access to information is to be created.

There will be two access modes to information: by headings and by context. Depending on the context user must be provided with access to different data bank's partitions. In case of query fail additional search iterations must be enabled.

Thus at the first stage of ESICN creation main effort is to be aimed at the development of technologies of data integration and access to data banks.

At the next stage there will be a task to create and develop of large-scale distributed data bank having self-modification ability (owing to independent addition of new information from RCs).

Further objective is getting access to other countries national and international networks, involving foreign users in using ESICN data bank.

Till the end of 1994 ESICN must encompass 5 RCs and serve not less then 30 users. It will make the ESICN self-provided with information since all RCs and great part of users will be not only information consumers but information owners as well. Promptitude of this information will be guaranteed both by information owner's interests and user servicing procedure limiting information lifetime. Solving of these problems makes it possible to reach high scientific and technical level of ESICN and provide it's practicability and availability for users.

A MULTIMEDIA PROJECT ON GYNAECOLOGY, OBSTETRICS AND GYNAECOLOGICAL ONCOLOGY FOR MEDICAL EDUCATION AND DISTANCE CONSULTING

INGEMAR JOELSSON
Department of Obstetrics and Gynaecology
University of Umea School of Medicine
Umea, Sweden Box 454, S-901 09 Umea, Sweden
Internet: injo@scicom.se or injo@biovax.umdc.umu.se, Bitnet: injo@seumdc51

Keywords: multimedia, interactive use of integrated media, distance learning, distance consulting, academic education, tele-medicine.

This project involves the transformation of a conventional Medical School Obstetrics and Gynaecology Curriculum into a program of interactive, integrated computer-based learning. Written and spoken text is integrated with sound illustrations, graphic images, animations and digital video to provide the students with a stimulating learning experience. According to this program, teachers will have the opportunity to act as discussion partners and moderators of meaningful group discussions. Another interface than the one designed for use in medical school, is being programmed for the use of the same data-base for continued medical education (CME) for specialists.

Once the curriculum and the first testing period are complete, this new program will be evaluated for its effectiveness as a tool for memorisation and understanding. Its program designers and evaluators represent the fields of pedagogics and psychology (esp. cognition research), and include a specialist on man-machine interaction, and a statistician.

Higher academic settings world-wide are built around conventional classroom lectures. While teachers are qualified in research and scientific writing, often they have no training in education. Moreover, as the amount of information increases dramatically, it is a challenge to keep educational material current. And, in many universities, the student population is increasing without a proportional increase in teachers. These factors all suggest a need for an alternative to the traditional academic environment.

Some national and international trials have been conducted to evaluate self-learning materials. The reports on increased effectiveness of self-instructional material are often based upon vocational training situations in the bigger factories. The reports usually claim that less training time is required but nothing is said about increased understanding or increased cognition. These things start to be of great importance in a society where the working conditions grow complex and changes are initiated more and more frequently.

The project goal is furthermore to provide distance consulting by the utilisation of a fiberoptic network available in the Northern part of Sweden for the transmission of data with the speed of up to 2 Mbits per second. Thereby dynamic data (digitised video in full colour representation with 25 (PAL) or 30 (NTSC) frames per second) can be transmitted from a rural health care station to a specialised hospital. The video can comprise ultrasound examination in colour, laparoscopic video film of pelvic pathology, or just video film of external lesions, for example dermatologic tumors.

The examination performed by the practitioner can be guided, judged and evaluated by the specialist. The two colleagues can talk to each other and discuss the significance of the findings during the procedure.

The same consultation, but less dramatic, will be possible using still images, such as pictures of preparations in the Pathology Department or X-ray pictures of fractures or NMR pictures of tumors. This type of consulting can also take place as a group discussion (video conference) with the patient, her nearby doctor and the far away specialist as talking participants.

The described consulting will save an enormous amount of money, time and travel costs. The distances in Northern Sweden are considerable, often a patient has to travel 250 to 400 km in order to be seen by a specialist. The just in time distance consulting will be considered as a break-through in medical care in the Arctic and Sub Arctic areas of northern Scandinavia.

EVALUATION OF THE TV OPEN LEARNING PROJECT IN AUSTRALIA

BRUCE D. KEEPES(*) & JILLIAN MAILING(**)
(*) University of Sydney F09 Sydney 2006 Australia
E-mail: brucek@extro.ucc.su.oz.au
(**) University of Western Sydney - NEPEAN P.O.Box 10 Kingswood 2747 Australia
E-mail: jmaling@uws.edu.au

Keywords: broadcast television, distance learning, university education, cost/benefit analysis, telematics.

Distance education has existed in Australian higher education since 1911 when correspondence courses were introduced by the University of Queensland. Despite this tradition of external studies, access to Australian higher education remained limited. Admission to the external courses offered by the Australian Universities was highly competitive and normally courses included a compulsory residential component, thus limiting access for a number of disadvantaged groups including people such as those from rural and isolated areas, sole parents with family and/or work responsibilities, and other groups for whom physical access to on-campus courses would be difficult.

In 1991 the Australian Commonwealth Government announced that $2 million would be allocated for a 1992-93 pilot project aimed at extending access to first year university degree courses by the provision of distance education materials in conjunction with broadcast educational TV. In particular, the project would focus on:

- Extending access to disadvantaged groups.
- Providing a 'taste' of higher education to those in the community who would not normally consider enrolling in a higher education institution.
- Trialing the use of television as a teaching mode for higher education.

The proposal was to develop educational television programs with associated independent learning materials in a small range of first year degree courses. Students would have the opportunity to participate in one of three ways:

- Option 1 - Watching the television programs only, thus gaining a 'taste' of the subject matter of the course.
- Option 2 - Purchasing and using study materials in addition to watching the television programs. The study materials would be available for sale on a cost recovery basis.
- Option 3 - Being assessed for study of the course (usually by examination). This would enable students to gain university credit. The challenge examination would be available to students on a cost recovery basis. These examinations were to be of comparable standard to first year courses offered by on-campus study. The examinations were to be scheduled at national exam centres throughout Australia.

A consortium of five universities was formed to provide the academic content, while the Australian Broadcast Corporation was given the contract to produce or purchase the TV materials for the seven courses which would be broadcast in 1992. There were to be no formal enrolment procedures or educational prerequisites and the opportunity to study in this mode was to be as "open" as possible.

Consortium members were given academic responsibility for the course in their designated area or areas. They were responsible for designing and developing the study materials, for liaising with the broadcaster on the production quality and programming of the broadcast materials, and meeting the Commonwealth's access and accreditation requirements for the Project.

The ABC, which broadcasts TV to over 98% of Australia, were responsibility for producing or purchasing the video materials in conjunction with Consortium members and promoting the TVOL programs on ABC radio and TV.

To evaluate the effectiveness of this mode of teaching tenders were called for an independent evaluation and a team of academics from the University of Sydney won the contract.

The year was divided into four study periods each thirteen weeks in length. This allowed year-round broadcasting, and enabled students flexibility not afforded by on-campus study. The television component of each course consisted of a series of thirteen or twenty-six week television shows. Seven TV Open Learning subjects (courses) were available during 1992. Two of the courses, Statistics and French, were purchased from overseas. Two courses, Images of Australia and Australian Environmental Studies, were totally produced in Australia. Three courses - Marketing, Religion Studies and Anthropology - were a combination of Australian and overseas materials.

There is no question that, measured on a number of criteria, TVOL was a roaring success in 1992. Over 3,700 persons purchased study materials for the First Study Period. A total of 5453 persons purchased study materials from a Consortium member during the year. Students came from virtually every part of Australia. The students were almost universally supportive of the concept of TVOL. The courses which were wholly produced in Australia compared very favorably with those purchased from overseas. And finally, the TVOL students who sat for assessment performed at a similar level to those who studied on-campus.

On the basis of very preliminary evaluation information the Federal Government decided to fund a much more ambitious project, the Open Learning Agency of Australia Pty Ltd (OLAA). OLAA is very much a result of a political decision. In 1992 there were some 40,000 or 50,000 students who were unable to enter a university because of quotas. The TV Open Learning approach provided a way to offer off-campus places to these students, at a cost much less than on-campus study. OLAA, which is in its first year of operation, is a 10 year project funded for $50 million for use in the first three years; for the next seven years the project is to be self-funding through student fees. The amount to be charged to students is about one-third of the amount the Commonwealth provides to universities for each full-time student.

SYSTEM SUPPORT FOR A MULTIMEDIA INTERACTIVE TUTORING SYSTEM

JIM M. NG
City Polytechnic of Hong Kong
Department of Computer Science
83 Tat Chee Ave., Kowloon, Hong Kong
csjimng@cphkvx.cphk.hk

Keywords: conferencing system, interactive tutoring, multimedia communication, CSCW.

In most educational institutions, tutoring and consulting services are provided to the students by having a special consulting room where students can meet the consultants or tutors face to face when they have any problems with their work. Since an increasing number of students are preparing their work with the aid of computers, queuing up for the tutors with printouts of error messages or partial results every time when assistance is required is not an efficient way to get assistance. In this paper, an experimental multimedia interactive tutoring system, MITS, will be described. Using the system, the students can seek advice without leaving their workstations. The tutor can view error messages or documents using the shared screen, and point to any location on the shared screen using a tele-pointer. Furthermore, a voice channel is set up so that verbal discussion can be exchanged between the student and the tutor.

For a tutoring session, it is often necessary for both the tutor and the student to view and access the same set of information. For instance, the student may want to show the tutor a program or segment of a program listing and any changes make by the tutor should be reflected on both the student's and the tutor's screens, i.e. a What-You-See-Is-What-I-See (WYSIWIS) environment is often desired. However, during the tutoring session, the tutor may want to look up other information

which does not need to be presented to the students; hence, the WYSIWIS requirement is too restrictive, and both the tutor and the student should be allowed to create private windows for the display and manipulation of private information. Private user application programs mapped to the private windows will then have local significance, and all editing and information manipulation will only be seen by the local user. On the other hand, once a file (or part of a file) is moved to the public window, both the tutor and the student can edit the file and any update will be seen by both parties.

By opening a public window, the tutor can exchange textual information with the student, and he can also amend the student's document or program. Furthermore, the student/tutor can load in any picture if necessary. With an image viewer, one can draw on or point at any location of the picture, so that the tutor can put marks on the picture during discussion. Besides exchanging data in textual form, a voice channel may also be established between the tutor and the student so that verbal communication is possible.

As it is desirable to cater for situation where a few students can join in the discussion during a tutoring session, a floor control mechanism is needed. Since the tutor has the highest authority, all requests of the floor will be routed to the tutor. The tutor will then pass the floor to any student. Furthermore, the tutor can take back the floor at any time so that he can manipulate the files. When there are more than one students making a service request, a first come first serve discipline will be used to regulate the service order. However, while waiting, a student may has his problem solved by himself or by his peers; hence, a student should be allowed to withdraw his request at any time.

MITS is composed of two subsystems: the applications subsystem and the conferencing subsystem. The applications subsystem provides the user interface and application service, such as text editor and image viewer to the user. The conferencing subsystem provides the low level conference management and data transmission services to the users, and it is composed of four main units: Transmission Manager, Session Manager, Conference Manager, and Public Windows Manager. A distributed model is adopted for our system where the tutor and the student(s) keep their own set of system status and parameters as well as copies of public window contents. Hence, when a public window is opened by the floor holder, say the student, a copy of the corresponding application will be invoked at the tutor's site, and the file opened or information put onto the public window will be passed from the student to the tutor. Any updates made by the floor holder will be passed to the conferencing subsystem which distributes the update operations to the tutor and vice versa. Since all stations see the same input and carry out the same process, their states will remain synchronized yielding identical output at each site.

THE DEMON PROJECT: AN INTELLIGENT BASIS FOR UKRAINIAN DISTANT EDUCATIONAL MONITORING

VALERY A. PETRUSHIN, VLADIMIR I. GRITSENKO, ALEXEY M. DOVGIALLO
Glushkov Institute for Cybernetics,
40, Prospekt Akademika Glushkova, 252207 Kiev, Ukraine
E-mail: petr%itslab.kiev.ua@fuug.fi

Keywords: distant learning, distant educational monitoring, Internet.

Today in Ukraine there are enough number of computers which are connected to distributed networks. From five worldwide computer networks (BITNET, INTERNET, UUCP, FIDONET, OSI) two networks UUCP (RELCOM) and FIDONET are widespread supported in Ukraine. It makes possible to connect to other networks all over the world. Mostly these networks use for supporting e-mail, for commercial and research applications. There are also several BBS for software exchange. There are no applications for educational purposes but this kind of applications is the most prevailing in Western countries using INTERNET network [1]. However we had some experience of educational networking in Ukraine because we have here about 150 schools which were chosen for participation in the IBM program "Pilot schools" for the USSR. These schools took part in HELLO and ACID RAINS projects which included exchange of letters and data by e-mail

(through UUCP) between soviet and american participants. At present a project for creating and providing the Educational System Integrated Computer Network is under development [2].

Among the main problems which are faced Ukraine in the field of development computer networks for educational and research purposes we should mention the following:

- Providing direct connection to INTERNET.
- Creating the Ukrainian National Educational Network.
- Developing the principles of an educational network applications, including organizing, hardware, software, and pedagogical aspects.

This year at the Glushkov Institute for Cybernetics the DEMON (Distant Educational MONitoring) project was started for solving software and pedagogical aspects of the third problem. Since "monitoring" means a process for supporting something in stable state then "distant educational monitoring" means the process for supporting knowledge of educational administrators, teachers and students about current state of educational systems in Ukraine and other countries, teaching methods, curricula, learning materials on various media including computer tutoring systems, and etc. on the base of distributed computer networks.

Today several outstanding projects are developing for INTERNET network:

- The GOPHER project [3], developed at the University of Minnesota, allows connection to the INTERNET resources using unified a menu-like user interface.
- The Wide-Area Information Server (WAIS) project [4], implemented by Thinking Machines, Apple Computer, and Dow Jones News/Retrieval, allows to perform full-text searches in the indexed INTERNET databases.
- The WorldWideWeb (W^3) project [5], developed at the European Particle Physics Laboratory (CERN), allows connection to the INTERNET recourses using the distributed hypertext browsing systems.
- The HYPER-G project [6], developed at the Graz University of Technology, is an universal hypermedia system which will be used as the basis for distributed university information system.

We consider the DEMON project has many goals in common with the HYPER-G, and GOPHER and W^3 are the samples of successful design of user interfaces.

The main goals of the DEMON project are following:

- Creating software and courseware for distant learning.
- Developing structure of databases and teleconferences on teaching methods, curricula, learning materials, and etc. for various subjects and levels of education.
- Developing software for creating, modifying, and maintaining distributed educational
- Developing the technology for creating computer-based tutoring systems.
- Developing techniques for using computer networks for distributed pedagogical experiments and expertise.

We consider educational administrators, teachers, and students as three categories of users. Educational administrators are the most privileged users. They will access to the all DEMON resources. Teachers will access to the main resources except some administrative data. However among administrators and teachers will be special users which will have the rights to modify public information.

The administrators' activities using DEMON will include: searching and maintaining of relevant legal documents, rules and regulations; meeting organization and maintenance of minutes; room management and timetabling; maintenance of student records, budget reports, etc.

The dominant teachers' activities will be: creating and distributing courseware and other learning materials; discussing questions of common interest through teleconferences; answering students' question by e-mail; taking part in distributed expertise of learning materials.

The students' activities will be: searching for relevant learning materials; browsing through relevant documents; choosing, fetching and executing courseware; asking questions e-mail and teleconferences.

In the future we consider to add other services such as the access to telephone directories (white and yellow pages), e-mail address directories, encyclopedia, specializes handbooks, and bi- and multilingual dictionaries.

The first stage of the project will take four years (1993-1996). It is supported by the Ukrainian Academy of Sciences.

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INTEGRATION OF DISTRIBUTED CAMPUS NETWORK AND NOTEBOOK COMPUTER IN EDUCATION

KAZUNORI SUGIURA(*) , NORIYUKI SHIGECHIKA(**) , HIROYUKI KUSUMOTO(***)

KEIO University, 5322 Endo, Fujisawa, Kanagawa, JAPAN 252

(*) E-mail: uhyo@wide.sfc.keio.ac.jp

(**) E-mail: nazo@wide.sfc.keio.ac.jp

(***) E-mail: kusumoto@wide.sfc.keio.ac.jp

Keywords: notebook computer environment, campus network and personal computer, multilingual environment

Introduction

KEIO University established a new campus called SFC(Shonan Fujisawa Campus) in April 1990. There are two faculties in campus - Faculty of Environmental Information and faculty of Policy Management. SFC is offering the new experimental computer assisted education and experimental systems based on the BSD Unix and network. More than 500 workstations and computers are connected together via the campus network systems (CNS). CNS consists of FDDI backbone and ethernet branches. Ethernet connections are available in all lecture rooms, meeting rooms, and faculty offices.

Education

Computer Literacy

A unique characteristics of the two faculties in new modern campus is computer literacy. All of the students regardless of the faculty, are required to study entry level distributed computer training courses called "Information Processing Language Course I" as soon as the first semester of the first grade starts out. Goal of this course is keyboard touch-typing, using electric mail, using network news and bulletin board systems, document processing, and preliminary programming language learning.

There are total of more than 4,000 students in SFC. All the students are required to use the workstations inside the campus as well as their own personal notebook computers in such as: traditional computer programming course; E-mail, netnews, and bulletin board systems; writing reports for the courses in SFC; natural language education.

Natural Language

At SFC, an intensive language training is used with the aim of cultivating practical language ability. There are English, German, French, Chinese, Korean, Japanese, Malaysian and Indonesian courses in the intensive training. Also we have a total of 10 second educational natural language course. The Computer assisted studying method such as below is fully used in the curriculum.We developed the new multilingual natural language education software called KUN. This system is based on Mule (MULtilingual Enhancement of GNU Emacs); supported in distributed computer environment and also in the notebook computer for the personal use.

Unix on Notebook Computer

Each students is required to buy an IBMPC compatible notebook computer for at-home work and personal usage [1]. It is strongly required to implement the same Unix architecture in SFC to personal computer environment. We implemented the same Unix architecture to the notebook PC using BSD/386 as a base operating system. Using Unix in personal notebook environment needs to clear the following problems.

- Using BSD/386 in the limited physical environment.
- Installation of X window system in notebook.
- Reduction of booting time(resume control).
- Implement the distributed network connection through the campus system using notebook computers.
- Implementing the same system management architecture in SFC to notebook.

Due to limitation of disk, memory, and display size on notebooks compared ato desktop workstations, reconfiguration of application is needed to fit the use in the notebook architecture. Redesigning of X window system application is needed to clear the problem of small pixel display. We also implemented a multilingual virtual console to support multilingual editing in console display without using X Window System as a displaying application. Also we implemented a DHCP [2] and VIP [3] Protocol for network connection of the notebook computer systems.

We have 26 modem ports for asyncronous terminal access from outside campus, such as students at home. We are planning IP connection from home. Mainly, students read electric mail and news from their home on night and holiday. Sometimes, students debug their programs, transfer their home-work reports to the network printer, or enjoy real time network communication with other students in the midnight. Additional modem ports are located in another campus of the university. Students may use these ports to avoid long distance calls.

Conclusion and Future Works

We developed the personal notebook computer operating system platform that suits the distributed environment of the campus. We have started the distribution of the notebook operating systems to students and staffs. There are still some problems in maintenance of the notebook systems. We developed the new computer assisted multilingual natural language education software running under the Mule editor.

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DISTRIBUTED COMPUTER MEDIATED EDUCATION USING ELECTRONIC MAIL EXTENSIONS

CHRIS TRATHEN
Technology Management Centre, Deakin University,
221 Burwood Highway, Burwood, Victoria 3125, Australia
E-mail: trathenac@brt.deakin.edu.au

Keywords: computer mediated education, distributed systemsm, electronic mail, multi-media, object technology

Introduction

We now are at the start of an era where fast, reliable communications will be as commonplace as the PC itself. The time is ripe for distributed applications. Distributed Computer Mediated Education (CME) combining the power of the PC and the speed of the optical fibre is an application that could open up education to a wide range of potential students and improve the efficiency of delivery to existing students.

A History of Computer Mediated Education

A brief look at the history of Computer Mediated Education and its divergence into the host-based style of system and the PC-based systems incorporating multi-media highlights a need for integrating the variety of functions found in CME systems into a single system.

A divergence of CME systems

Until recently CME software resided on minicomputers or mainframes. Users accessed the CME software by using dumb terminals, or sometimes purpose built peripherals. The introduction of microcomputers allowed more widespread use of CME software. While facilitating more sophisticated user interfaces, this has lead to lack of central control.

The focus of CME has been orientated toward sophistication rather than the equally important areas of management and assessment.

Do we need distributed CME?

Changes in the workplace have had an impact on methods of training and education. There is a growing need for flexible methods of course delivery; distributed CME is an attractive solution. The

economics of courseware development highlight a need for more efficient use of any courseware that is developed. Distributed CME is a cost-effective way of sharing the development costs.

This need, coupled with the recent advances in connectivity and the emergence of multi-media transport standards, show that a distributed Computer Mediated Education system is not only desirable but achievable.

Multi-Media Electronic Mail across the Internet

The X.400 and MIME electronic mail delivery standards are examined to assess their suitability for CME extensions so that CME applications can be distributed across the Internet.

An Object-Oriented extension to electronic mail to facilitate distributed Computer Mediated Education

A protocol using Object-Oriented techniques is proposed. This protocol extends electronic mail by adding a special content-type called a CME object and is intended for extension of the MIME standard. The CME object content-type is composed of methods and data. One of these methods is an initiating method.

7. Conclusion

The techniques and technologies needed for distributed CME now exist. We have fast PCs, fast network access, advanced computer-human interfaces incorporating multimedia, and software engineering methodologies suited to loosely coupled distributed systems.

The need for cost-effective, flexible training and education is clearly evident. Distributed CME applications are a way of fulfilling this need.

A distributed CME protocol using Object technology has been suggested. It is hoped this will pave the way for widespread use of distributed CME.

TELECOMMUNICATION IN EDUCATION - AN ISRAELI EXPERIENCE

NOMIKA ZION(*), GEDALIAHU ZILBERBERG(**)

(*)Site Coordinator for Makash, a nonprofit corporation for furthering social and educational goals through computer communications.

(**)Consultant for the Integration of Computers in Education and Remedial Teaching.

E-mail: gedalia@pluto.cc.huji.ac.il

Key words: Telecommunication, electronic mail, secondary school, integration of computers into the curriculum, Global Village.

Computers and telecommunications technologies are introducing new concepts into educational theories, and new possibilities and conditions to student's learning. They involve processes that are connected to many areas of learning, tending to blur the lines which customarily divide subject-specific teaching. These technologies help to improve thinking skills, interpersonal and intergroup relationships.

The aim of the project is to enhance the integration of computers and application programs into and across the curriculum, through telecommunication and electronic mail. To introduce learning processes that incorporate social and cultural studies, sciences involving disciplinary and interdisciplinary research, and how to conduct it.

The project provides students with the opportunity to share ideas, and to learn more about themselves and their e-mail conferee peer - Electronic Pen Pals: Through this media, pupils make comparisons of their specific environments about the similarity and the difference of their way of

life, their cultural world, mentality, customs, schools' system and other aspects of daily life. It also gives them a wonderful opportunity to practice creative writing and improve other writing skills.

The set up of the project: This project includes groups of students from different secondary schools in Israel (between the ages of 14- 17), who communicate with each other by means of IBM computers and modem. The project encompasses students with different S.E.S. backgrounds: Kibbutzim, Moshavim (types of cooperative settlements), developing townships, and cities all over the country. In each school the project is run by a team of teachers representing the subject matter, the technology and educational aspects. The number of groups in a school depends on various conditions. Each group meets once a week for 3 hours in the afternoon in a computer's class. There they work with their teacher on certain topics, write their compositions, papers or letters, using a word processor, and post them through electronic mail at the end of the meeting.

Activities: The students write personal letters, articles and reports. They express their ideas about political and social problems in Israel; and explore other important issues like the meaning of the youth-movement today; drugs; sex; love; relations between teachers and students; family's problems. They also work on other sorts of activities like: "Identity-card," dreams, fears, writing chain stories, playing games and quizzes, discussing musical tastes, careers, and so on. Conclusions from experience gained during this year will be presented at the conference.

Plans for the future: Makash and the Global Village Makash is now working on extending its project to create links in the english language, with classes and students from different countries and cultures. The idea is to exchange information and discuss ideas that are of mutual interest, in informal and unstructured, as well as structured ways, based on scientific reasoning. The links could be build between individuals in a class, and between groups.

KNOWLEDGE-BASED SYSTEM DESIGN AND PARALLEL COMPUTING AT MULTIPROCESSOR COMPLEXES

FILIPP I. ANDON, BORIS E. POLYACHENKO, NATALIYA B. LIMONOVA
Institute for Software Systems,
Ukrainian Academy of Sciences
40, Prospect Akademika Glushkova
252207 KIEV, UKRAINE
E-mail: CRIT%SOFTGIC.KIEV.UA@RELAY.USSR.EU.NET

APPROACH FOR PARALLEL COMPUTATIONS

Original parallel computations techniques [1]-[4] for Data Base (DB) and Knowledge Base (KB) parallel processing have been suggested, investigated and implemented in experimental version of object-oriented dBASE compatible system, TRANSBASE [5].

The vertical paralleling technique (VPT) supports the computations in asynchronous way controlled by DB and KB items accessibility. VPT provides parallel processing of depended by DB (KB) statements (query graph) with minimal volume of exchanges with these DB (KB).

Horizontal paralleling technique provides data structure decomposition and its parallel processing in multiprocessor environment by means of equivalent transformation of the DB, KB processing statement into the number of such statements, each of which processes its own substructure of initial structure. These statements are processing in parallel way. Data structure binding technique supports logical inference on the data structure level.

For formal DB and KB query representation and optimization special algorithm's algebra under the memory is introduced. This algebra defines the set of elementary conditions, the set of elementary functional statements, the set of elementary statements for communications with external informational environment.

INTELLIGENT SYSTEM DESIGN IN PARALLEL ENVIRONMENT

Intelligent system design will be considered on the example of parallel intelligent decision system (DSS) synthesis by means of proposed models usage for system description and development. Such class of systems are based on expert systems and parallel knowledge based computing systems and introduced to provide support to the human decision makers at the management level in distributed manner. This work provides theoretical and practical guidelines in the development and management of such knowledge based DSS on the basis of above suggested models, techniques and tools. Multiprocessor computing systems with local/distributed DB and KB are capable of monitoring and controlling subsystems while exchanging information via data networks with other systems and providing the interface with human desicion makers that acts as upervisors and managers. These tools provides intelligent shell and interactive design process for knowledge based DSS in parallel environment of multiprocessor sytems with various architectures.

OBJECT-ORIENTED PARALLEL PROGRAMMING LANGUAGE

Simple and convenient high level parallel production-based programming language, ACORD (Asynchronous COnstruction of pRograms for Data processing) oriented to complex data processing program design from sequential data processing (DP) statements and reflected asynchronous style of programming has being suggested as extension of [4]. All described in the program actions are supposed as potentially parallel, independent, and their scheduling are produced by the language (system) supporting tools.

ACORD-program consists of following structural parts:

- DECLARATIONS to define DB and KB logical structures.
- FACTS to reflect real problem domain (A set of functions-free clauses with no variables).

- RULES (Axioms) (A set of nonrecursive range-restricted functions-free definite Horn clauses).
- INTEGRITY CONSTRAINTS (A set of nonrecursive range-restricted Horn clauses).

After specification of above mentioned parts the inference rule on the set of ACORD-items is given by the user (in interactive or package mode) from the set of possible ones.

TECHNOLOGICAL ASPECTS

TRANSBASE supports new protocols and programming discipline to synthesize parallel software, transform the sequential software into the parallel one have been suggested, investigated and implemented. This approach is based on above mentioned original methods of parallel processing.

TRANSBASE provides in interactive mode the synthesis of parallel software from sequential one, written by such standard languages as C, Pascal, FORTRAN. Each program module uses only record-oriented tools to present input/output data.

Transformation of the sequential software into the parallel one for distributed multiprocessor environment is provided by means of proposed tools.

No application program modification is required.

PARALLEL COMPUTATIONS OPTIMIZATION

The most important phase during system exploitation is efficient computations organization. Here only the sketch of computations optimization is considered with maximal possible semantics taken into account.

- To introduce the partitial ordering on the set of rules. To construct Dependency Graph and its partitioning into the set of Subgraphs both in relation with resource, other technological constraints, system exploitation statistics and DB stratification.
- Provide parallelism at all stages of rule management: conflict set organizing, selection from conflict set, rule initiation.
- Parallel semantic resolution with metaproductions usage.
- Optimization itself based on above mentioned approaches during distributed computing environment support [2, 3].

PARALLEL SOFTWARE SYNTHESIS AND EVALUATION

Parallel application software products synthesis is provided by means of our tools from sequential modules written by such traditional languages as C, Pascal and FORTRAN with standard tools of record-oriented input-output being used. No application program modification is required.

Performance evaluation has been realized in 3L parallel transputer environment for IBM PC/286. dBASE files were stored on PC hard disk. Their processing were organized both by means of standard DB tools and under TRANSBASE control. The implementation under TRANSBASE control provides 2.796 - 7.461 times decreasing the execution time of the DB processing problems on 3 transputers (TRANSTECH TTM6-8-F) depending on problem class, if compared with standard dBASE tools [5].

IBM OS/2 2.0 and 1.3 implementations are also based on above described approach to parallel multiprocesses Object-Oriented system to manipulate with DB and KB. Uniprocessor version provides maximal level of parallelism based on multiprocesses mode of IBM PC based DB server.

This system provides high level interactive tools to adapt to the current environments and learn the users. The user has the possibility to simulate any situation and set of technological stages in interactive mode.

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LOCAL SEMANTIC NETS USE FOR MATHEMATICAL KNOWLEDGE REPRESENTATION

NATALYA APATOVA

44, Simferopolska str. , Simferopol

Crimea, 333023, Ukraine

Keywords: semantic net, mathematics, training matter, on-line tutorial expert systems

The most complicated task of on-line tutorials development is the knowledge formalisation of the application domain.

Training aims determine the plurality of concepts under study which may include small quantity of elements for specific age group. Studying the relations between the concepts creates the notion about the subject and is the main link of education but depends on methodic concepts of the text-book authors.

Up to the present day existing centralised education - united programmes, text-books and curricula - is the reason that the generations of people have the same gaps in education because they don't understand the cause and effect relationship between the concepts. On-line tutorial expert systems are designed to eliminate such gaps and help the user not only to master the domain concepts but to follow various relations between the concepts.

Thus knowledge formalisation makes it possible:

- To create question-answer computer systems which permit the user to put questions and get not only the definitions of separate notions but also the discourses by tracking the internotion relations or the logic conclusions chains.
- To develop training appliances to solve the problems, where each step is explained.
- To rearrange the training stuff in compliance with the different strategic tasks and after systematizing acquire new knowledge;
- To analyse inner subject structure revealing deadlock and perspective notions , their relations, which help to improve the training courses.

On-line tutorial expert systems are necessary for the students independent work at all educational stages from the junior up to the senior school age. The combined on-line tutorial and knowledge base on the subject help the student to draw independent conclusions proving their correctness or erroneous. In such way we have the on-line tutorial expert system of any volume for any subjects.

Mathematics is one of the complicated school subjects. It admits a number of restrictions and assumptions which are not always clear to the student.

For example, quantitative restrictions (it's difficult for a schooler to operate with great numbers using pen and paper only), space restrictions (function graphic is displayed in the beginning of the coordinate systems, to the nearest infinity region the graphic is stretched mentally), restrictions of the notions correctness when only primary examples are discussed (e.g. an angle is defined though the beams - their length is not limited and when the notion "triangular angle" defined through the segments, no more explanations are given).

Knowledge base may include such specified definitions and the computer enhance those restrictions.

Local semantic net is sufficient for introduction elementary maths data. Network nodes contain basic notions, characteristics, usage examples, and graph's edges relations: higher, more common notion; lower, detailed, more specified; notion characteristics and explanations; examples of the notion use, practical implementation of the rules. The path along the network can be fixed by methodic interests or chosen by a student. The entry points are the course notions.

COGNITION COMPUTATIONAL STRUCTURES (CCS)

PIERRE BAZEX(*) , RAYMOND COUSIN(**)
(*) IRIT Laboratory, University Paul Sabatier
118 route de Narbonne, 31077 TOULOUSE, Cedex, FRANCE
(**) ARAMIIHS Laboratory-Matra Marconi Space UPS/IUT/GEA II
50 A, Chemin des Maraichers, 31077 TOULOUSE ,Cedex, FRANCE
e-mail : cousin@bdr2.irit.fr

Keywords: ITS, apprenticeship simulators, knowledge representation and acquisition, dynamic knowledge bases.

We present in this paper a new architecture for simulator generator for apprenticeship, training and perfecting of the personnel affected to the administrative conduct of a complex industrial universe. This architecture is formed by a dynamic set of evolved knowledge bases. The main computer characteristic of this architecture has been considered as a repetitive assembly of the same data structure type instanced under the different and multiple facets of knowledge notion. In increasing the semantic space, this architecture offers the flexibility, evolutivity and dynamism properties required by such generators and by the different users.

The construction logic of the computerize architecture to realize, is based on the wish to reduce as much as possible the number of concepts that are the foundations of this simulator generator. In exchange, it needs to make easy diverse assembly modes of those base concepts in order to bring the properties of flexibility and evolutivity necessarily to the adaptation of a simulator solution to the observed universe *U*. To do that, we use a structure model similar the entity-relation model with a repetitive manner, like an element of knowledge base assembly.

This model of canonical structure is a model using the notions of attribute, class, occurrence of relation and structure. Classes and relations possess attributes. A structure is a connex network of classes and relation occurrences. Each structure relative to *U* is a representative semantic network of a partial knowledge about the observed universe *U*.

This gait brings the easiness to :

- Designing the knowledge by a neuter language (professional inter- language), the one of the canonical structure
- Manipulate knowledge by construction of a deductive, associative, discursive or by request credit mechanisms, come from those assembly techniques.
- Control those knowledge so much on their semantic organisation plan than on the one of their exploitation.
- Build by an incremental way partial structures of *U* but integrative in a much vast set that is an image of *U*.
- Transform structures : rewriting for the adaptation to problem wording or to the requests on the *U* representation.

We call fact an element composed, according to the lay-out of the used concepts in the structure, of one or several class instances and possibly of relation occurrence instances. The structure extension is a an facts set.

All structures and their extensions can be memorised in a computerize structure called Structure Space (noted *SS*). An *SS* is represented by a graph (meta-scheme *SS*) where, on the one hand, the tops represent respectively the sets of attributes, classes, relations, attribute valuations, class instances and relation occurrence instances, on the other hand, the arcs represent the structural connections between these sets.

All structures S_1, S_2,... S_k of a *SS* are interconnected by an interplay of annex structures, named co-structures. The co-structures are the structuration (various meta-knowledge levels) of common elements which lead or explain structures S_k. All these co-structures have the canonical model. Among designed co-structures at present, quote us the structure of structures S_k, the meta-structure des S_k, the structure of rules, the structure of correspondences between S_k, the structure of process, etc.

Diverse structure constructors are applicable to extend present structures (creation of new concepts; structure transplantation and transformation operators into another structure by coherent transcriptions with structural inferences...).

The second transformation source of an *SS* to a dynamic knowledge base is that realised by the dynamic elements (noted *DE)* construction processes. A dynamic element, linked to a concept or a fact, element of a S_k, has the property to dispose of a functional potential capable to activate, by itself or with the help of another *DE*, after a stimulus reception (object-oriented programming at the user-conceptual level,meta-programmation and meta-evaluation).

The third transformation source of an *SS* to a cognitive system is that supplied by special functors, called knowledge-functors (in sense of categories theory; for examples: inductive functors, transitive fonctors, etc.) applied to meta-scheme *SS* considered like a category (morphisms are semantic connections between structures and co-structures). Such tools maked sufficiently adaptable and evolutive turn co-structure into real observation ways of knowledge acquisition techniques and dynamic cognitive ergonomic.

By this way, structures S_k become Cognition Computational Structures *(CCS). CCS* are widely used in our simulator generator architecture.

A KNOWLEDGE BASED PROBLEM SOLVER CONCEIVED FOR INTELLIGENT TUTORING APPLICATIONS

J.M. BAZIN(*) , P. CASTELLS(**) , R. MORIYON(***) , F. SAIZ(****)
(*) Laforia, Universite Paris VI et Universite de Reims Institut Blaise Pascal,
4, Place Juissieu, 75252 Paris, cedex 05 ,France
E-mail: bazin@laforia.ibp.fr
(**) Instituto de Ingenieria del Conocimiento,
Universidad Autonoma de Madrid, 28049 Madrid, Spain
E-mail: castells@iic.uam.es
(***) ISI/USC, 4676 Admirality Way, Marina del Rey, CA 90292-6695, USA
E-mail: moriyon@isi.edu
(****) Instituto de Ingenieria del Conocimiento,
Universidad Autonoma de Madrid. 28049 Madrid, Spain
E-mail: saiz@inc.uam.es

Keywords: problem solving, knowledge base, knowledge representation, metaknowledge, cognitive model, automatic theorem proving.

Problems related to scientific domains like Mathematics or Physics have specific characteristics that require the assimilation of specific concepts and skills to handle them. Progenes, system that is able to solve conceptual problems of both fields at High School or first year College level, and is well suited for its integration in an interactive tutoring environment.

Besides its appropriateness for pedagogical purposes, Progenes is also a powerful problem solver by itself. Many of our techniques are taken from Muscadet, conceptual problems in domains like Point Set Topology and Functional Analysis. However Muscadet needs to apply sophisticated mechanisms when dealing with a simple computation like 2+2=4. Instead, Progenes is able to use rule based automatic reasoning and formal calculus routines in a cooperative way. Metarules are responsible for deciding whether to use inference or to do calculations at a particular step of the resolution, taking into account a pedagogical contract between the student and the teacher: proving something is much harder than calculating it, but may be more didactic. As a consequence of this, Progenes can solve easily problems that involve both conceptual and computational aspects, what is a great improvement with respect to traditional Automatic Theorem Proving systems like the previously mentioned.

Progenes is able to solve problems like the following, starting from a formal representation of the statement:

"Find the plane that passes through the points (4, 0, 0) and (0, 8, 0), and is tangent to the ellipsoid centered at the origin whose axis have lengths 1, 2 and 1 respectively."

The main component of the system is a Knowledge Base that is built from a cognitive model of a teacher, including the purely mathematical knowledge of the domain, and the know-how (meta-knowledge) of both proving strategies and pedagogical aspects, taking into account a model of the student.

The Knowledge Base contains declarative knowledge and procedural knowledge. The latter corresponds to knowledge that is assumed to be known by the student, according to the didactic contract ("May I use the calculating machine?"). The normal vector to a surface at a point for example, is given by the gradient of the equation of the surface. A symbolic calculus tool, Mathematica, this knowledge in the form of rewriting rules.

Declarative knowledge consists of definitions, rules and metarules, and deduction is based on it. For example, an ellipsoid is defined by its center (a point), and the lengths of its three semi-axes (real numbers). Moreover, certain properties and theorems are stated in form of rules, and much of the metaknowledge of the system is encoded by means of metarules, and knowledge that are relevant for the problem, using keywords, characteristic configurations, and other kinds of meta-conditions. Others are involved with making choices.

Mathematical expressions and whole statements like the one given above, are represented by means of a strongly typed formal language. Progenes Language supports Object Oriented Programming, allowing heterogeneous representations along hierarchies, by using a general class of type translation functions, instead of the usual structure inheritance between types. For example, "circumference" is a subtype of "set". A student can represent a circumference by its center and radius or by an equation at different stages of the resolution of a problem.

Choosing the right representation is a crucial issue when solving a problem, and students must learn to move from one representation to another depending on the requirements of the problem, by applying the appropriate translation procedures. According to this, our system includes specific mechanisms for that purpose which provide the needed flexibility.

This question arises also when, for example, a student has to decide whether or not to use coordinates in a problem involving points and curves. Responding to that and similar situations, Progenes provides a solving strategy, the EXpansion Algorithm Module (EXAM), which reformulates problems about complex concepts (points, surfaces, mechanical systems, etc.) in terms of simpler objects that Mathematica can handle (numbers, functions, differential equations, etc.). However, some problems are solved much more easily by avoiding coordinates. The decision to put EXAM in action is controlled by metarules that predict the effect of the algorithm on the problem, using (meta)knowledge about what kind of problems we are able to solve and how we can solve them.

We have developed several knowledge bases for different domains, obtaining significant improvements with respect to existing Theorem Proving systems when dealing with problems that require both conceptual reasoning and formal calculations.

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TREE-LIKE RULES AS A MEANS OF KNOWLEDGE REPRESENTATION IN EXPERT SYSTEMS.

V. BILLIG

Tver State University

41/7 Farafonova Str., #7, Tver, 170005, Russia

E-mail:billig@tvegu.tver.su

Keywords: expert system, knowledge representation, knowledge based system,teaching system,tree-like rule, production rule.

Many features of knowledge based systems make them useful for education purposes. It is true for special teaching ES as well as for professional ones. The means of knowledge representation play an essential role. On the one hand, the form of knowledge representation must be powerful enough

to allow the expert to represent his knowledge adequately.On the other hand, such common mathematical tools as quantors and recursion do not belong to the thinking style of the expert.Far more important for him are the tools of knowledge structuring and visualization. These questions were basic in developing the shell of ES "Lector".

The purpose of the report is a detailed consideration of the so-called tree-like rules as a form of knowledge representation in ES "Lector".The experience in teaching students shows that in developing teaching ES as well as professional ones in the field of geophysics this form is most intensively used. It can be explained by the fact that knowledge structuring in tree-like form is more natural for many problem domains.

The tree-like rule $T(A,B)$, where A,B are its input and output variables, defines the group of production rules. Each branch of a tree defines one production rule. The condition of the rule is connected with the branch and the conclusion - with the leave of this branch.

Input variables can be divided into VAL and ORD - variables. VAL - variables can have values from a finite set, ORD - variables are connected with order relation.

The tools of "Lector" allow the expert to create tree-like rules easily enough. The system automatically generates branches of full production tree and associated conditions.The expert must only make decisions about output variables value on the tree leaves.He also has an opportunity to reduce the tree. He is allowed to rise to any tree node and make a decision in it, the system controlling his actions and ensuring correctness of the decisions.

Tree reduction is essential in the work of the expert.The number of decisions to be made in the full tree is great. It grows exponentially with the number of input variables determining the tree height.Automatic generation of the full tree is a guarantee that the expert will analyze all the decision variants. Reduction allows to reduce the number of the decisions made by the expert, there often being no need to analyze the values of all input variables. It is interesting to note that with such technology of work the system assumes a new quality. Usually the expert makes decisions only in the situations they exist in. Now he must explain why making a correct decision is impossible in a certain situation.

A tree-like rule is more efficient in storage and time than the equivalent system of production rules.

In conclusion note that some professional expert systems in geophysics as well as systems in teaching school geometry, chemistry and some other problem domains were created using the shell ES "Lector".

APPLICATION OF TECHNIQUES OF AUTOMATIC PROBLEM SOLVING TO COMPUTER INTELLIGENT TUTORING

P. CASTELLS(*), R. MORIYON(**) , F. SAIZ(***) , E. VILLA(****)

(*) Instituto de Ingenieria del Conocimiento,
Universidad Autonoma de Madrid, 28049 Madrid, Spain
E-mail: castells@iic.uam.es
(**) ISI/USC, 4676 Admiralty Way, Marina del Rey, CA 90292-6695, USA
E-mail: moriyon@isi.edu
(***) Instituto de Ingenieria del Conocimiento,
Universidad Autonoma de Madrid, 28049 Madrid, Spain
E-mail: saiz@iic.uam.es
(****) Ministery of Education and Science Madrid, Spain

Keywords: intelligent tutoring system, mechanics, problem solving, cognitive model, man-machine dialogue

This abstract describes the interaction between KITS (Knowledge-Based Intelligent Tutoring System), an expert program that solves automatically problems of Mathematics or Physics into a level of High School or a first course of University and a student. This model allows a dialogue machine-student where the computer supports dynamically a model of the directly procedural knowledge of the student.

KITS is based in Progenes, an automatic problem solving system for problems of Algebra and Infinitesimal Calculus developed in the Institute of Knowledge Engineering (IIC) at the Universidad Autonoma de Madrid, (2), (4). The program includes an implementation of a knowledge model of the domain at the level of an outstanding student. It is an object based system, where objects are described by means of a hierarchy of types. It uses procedural and deductive knowledge. The deductive knowledge is described by means of a set of production rules, and the procedural knowledge is developed by means of rewrite rules that can be implemented in Mathematica (5), a system of symbolic manipulation that is also used like an expression language of the concepts that appear in a problem. Our system added to the functional capabilities of Progenes the capability of dynamically creating and updating directly procedural knowledge by means of rewriting rules.

The model of the student used by our system has been described elsewhere (3). The interaction with the student at a conceptual level occurs by means of a system of production rules, that allows for the development of solving plans, recognizing the plans that have been used in a step of the solving process and supporting a dynamic model of the facts that a student knows about a problem, (1).

Our description will be based in the next example: A vehicle starts moving with an acceleration of a $m/seg.2$. A truck passes by at that instant with a constant velocity of $v\,m/seg.$ At what distance of the initial possition will the vehicle catch the truck?

First the computer makes the student to enumerate the relevant objects of the problem. In this case there are two instants, two possitions and two vehicles. Besides this, the class "vehicle" includes several subclasses that depend on the type of movement under consideration. In this case there is a vehicle with uniform movement and there is another vehicle with a uniformly accelerated movement.

After that the student has to enumerate the relevant facts of the problem. In this case we know that the initial and final position of the vehicle and the truck are equal.

Finally the computer asks for the objects that are searched. In our case this is the distance covered by both vehicles between the two given instants.

The student can establish a dialogue in order to get the information that the computer is asking him for, or to check its correction. He can also ask the computer for indications about how to solve the given problem. The computer can also start a dialogue in order to correct the student.

However the essential subject of the interaction is the elaboration and recognition of solving problem plans. The student can ask what are the possible methods of resolution of the problem. The

computer answers with an ordered list of them. And when the student decides to use some method, like for instance using coordinates, the computer can check if the statements the student is making are correct, and if they correspond to the method he chosed. These statements can refer to translating the known facts into coordinates, applying Physics laws, making substitutions, solving equations, etc. The system is also capable to decide what are the plans that the student is using and to correct him if they are not adequate. If the student selects a formula to get some unknown magnitude and he does not have enough information to get it, the system lets the student know about this inconvenient.

When the solving process has finished the computer can establish alternative ways of resolution in order for the student to solve it again in a different context. For instance, if the student has established that the original position of the vehicles is the origin of coordinates and that the second point is positively oriented and he has applied correctly the formulas that describe this kind of movement, the computer can pose him the alternative to change the direction of the orientation, in order to check that the student is able to work in the new system of coordinates.

In conclusion, the use of the power and flexibility of the Progenes system together with the dynamical instantiation of procedural knowledge allows an interaction with the student with a rich semantic feedback that makes the student know better the concepts and resolution methods he does not know well.

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EXPERT SYSTEM SHELLS AS COGNITIVE TOOLS: UKRAINIAN EXPERIENCE

ALEXEY M. DOVGIALLO, VALERY A. PETRUSHIN

Glushkov Institute for Cybernetics

40, Prospekt Akademika Glushkova,

Kiev 252207, Ukraine

E-mail: dovgkiv@sovam.com and petr%itslab.kiev.ua@relcom.kiae.su

Keywords: expert system shell, cognitive tool, training course for teachers, knowledge mapping.

In spite of using computers (but often even due to using computers and multimedia equipment) the main didactical resources are devoted to reproductive learning, i.e. to present students a proper "summa scientia". It means that student's activities are reduced to memorization of facts, formulas, rules, techniques for solving typical problems, etc. Indisputably any secondary school leaver must have knowledge of principles of various sciences, and any fresh specialist must have a proper "critical mass" of knowledge about his/her problem domain. In time facts became unimportant, and new theories, rules, viewpoints, etc. are arrived. As a result the student's knowledge became non-actual, and he/she cannot cope with new arrived problems in the complex world. This is why

one the main didactical problems is the problem of development of student's cognitive abilities (productive thinking, learning to learn, etc.) to enable them to be adaptive in dealing with the increasingly complex future.

To solve the problem we propose to use artificial intelligence tools as cognitive tools. The most appropriate tools for education are simple systems for building problem solvers, expert system shells [1,2], shells for creating hypermedia applications [3] and conceptual semantic networks [4]. The kind of tool is chosen taking into account didactical objectives and the degree of formalization of subject being studied. However in any case a cognitive tool is a learning environment that gives student resources which he/she uses to present his/her knowledge, and "to teach" a computer to solve problems or to model the structure of knowledge for the subject being studied (the problem domain).

The result of student's activity is a descriptive (when a shell for creating hypermedia systems is used) or operative (when a problem solver builder or an expert system shell is used) knowledge base which represent explicitly concepts of subject being studied, links between concepts, rules and strategies for solving problems. The knowledge base is an approximation of the student's "cognitive map" about the problem domain under consideration. A teacher is afforded two possibilities for evaluating students' knowledge. One can

- Watch the students' application behavior, and
- Study the structure of the students' application.

This explicit presentation of students' activity results may help to evaluate the students' knowledge more deeply and correctly.

Since 1989 at the Research and Training Center IIP/UNESCO of Glushkov Institute for Cybernetics the courses "Introduction to expert systems" and "Expert systems in education" are lectured. The former course is intended for wide circle of uses which would like to get to know the principles of expert systems design and application. The main objective of the course is to create motivation for students, that is why it has the practical orientation. The course takes 12 hours (2-3 days) and includes 2-hour lecture about purposes, structure and applications of expert systems, inference engine types, etc.; 1-hour class for demonstration and mastering a simple expert system shell BESS, which is based on Bayesian approach to decision making [5]; 8-hour workshop on design and implementation simple prototypes of expert system; and 1-hour class for the competition between students' prototypes and discussion the results.

The latter course is intended for educationalists in the first place for secondary school and university teachers. The objective of the course is to teach educationalists about expert systems, how to use them in education with emphasis using expert systems shells as cognitive tools. The course takes 36 hours (6-8 days) and consists of two parts. The first part takes 12 hours. It is similar the former course and takes into account the target audience and the objectives of the whole course. The second part takes 24 hours that include 3-hour lecture about using expert systems in education with demonstration expert systems prototypes, two 10-hour workshops, and 1-hour general discussion.

The first workshop is devoted to application expert systems for diagnosis and assessment students' knowledge. The main its objectives are:

- To introduce the concept of student model.
- To demonstrate how inference engines used in expert systems may be apply for diagnosis and assessment students' knowledge.

The second workshop is devoted to preparation an introductory course to expert systems or an applied workshop for using the expert system shell as a cognitive tool for secondary school and university students. It is supposed that a student first should take an introductory course (as a part of informatics course), and then he/she would use the expert system shell on specialized workshops devoted particular subjects, such as chemistry, biology, geography, etc. Hence, during the second workshop teachers are separated: the informatics teachers are preparing their introductory courses

(they deal with methods for presenting the concepts of expert system, expert system shell, Bayesian approach to decision making, etc.), meanwhile other subjects teachers are preparing their applied workshops (they deal with presenting the problem, creating the sample expert system, developing criteria for students' result estimation, methods for workshop organization, conducting an experiment and processing data). Every workshop includes 1-hour class that is devoted to presentation of the problem and the methodology for solving it; 8-hour laboratory work to create and debug expert system prototype, and to prepare teaching materials; and 1-hour class to demonstrate and discuss result.

During the general discussion teachers estimate and discuss ways for applying expert systems in education on the base of their experiences.

The above courses were presented to various categories of users (students). The total amount of students is more than 300 persons. The courses were conducted in Ukraine, Russia, Azerbaijan, Kazakhstan, Cuba, Syria [6], and India. At present time researchers of the Glushkov Institute for Cybernetics and the Institute for System Investigations (the Ministry of Education of Ukraine) are developing a project on application expert system shells as cognitive tools for 10-11 form secondary school students in Ukraine. Until the end of 1993 the textbook for teachers and students will be prepared, and the pilot experiment will be conducted.

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TUTORING EXPERT SYSTEM IN COMPLEX DOMAINS

ANDREW DZENGELEWSKI , SHAMIL NIZAMETDINOV, VICTOR RUMJANTZEV,
ALEKSEY ZAROVNY , IVAN DEMONOV & EGOR TULAGIN
System Analysis Department, MIFI,
31, Kashirskoe Shosse, Moscow, 115409, Russia

Keywords: tutoring expert system, data analysis, network design, situation expert system shell, problem situation,knowledge uncompleteness, knowledge contradiction, graphical visualisation of knowledge.

A tutoring expert system requires strongly follow possibilities:

- To observe a logical inference.
- To receive complete explanations of decision select.
- To value knowledge uncopletenesses and contradictions.

The tutoring expert system for data analysis has been constructed using the Situation Expert System Shell (SIESS) and is suiting to this demands. SIESS is the shell for decision making system create.

A student deals with three main SIESS options:

- *Tuition.* It is an operation mode to consult in application of an interface, protocol or mean. A user answers questions connected with current problem situation (PS), gets relevant recommendations and, perhaps, turns to the next PS. The mode of the manual backing up gives an opportunity "to travel" about knowledge base (KB) to get to know problem domain better.
- *Explanation.* It is a standard function of an expert system, where a user is given an opportunity to know how the recommendation was inferred or why the question was asked. When questions about using notions are appeared it is possible to get information from the base of notions which is developed on hypertext principles.
- *Show.* It is a mode of graphic visualization of KB (or KB fragments) structure which generally represents problem area structure.

A teacher or course's constructor can complement or correct KB during an input of notions, recommendations or situations by means of SIESS subsystem of knowledge elicitation in the dialog mode. Concept input is based on hypertext model. Knowledge input is possible as learning by examples or according to SIESS original method.

In the last case there done as follows:

- The expert forms a KB structure as the net of connected PS's.
- For every PS, the expert inputs the PS decision.
- The expert selects PS factor values for this decision.
- SIESS finds the intersection values area for the new and old decisions.

If the intersection exist, this contradiction is solved in the dialogue with expert by one of follow ways:

- Both decisions are removed (uncompleteness).
- One decision is stayed.
- Both decisions are stayed and will recommended simultaneously (contradiction).
- The dividing factor (construct) is added.

- If there is next decision, then the procedure is repeated.

The simplicity of the system user interface allows students with profound knowledge in some problem domains to complement KB by themselves.

The special our system characteristic is using it during the three phase of tutoring:

- The familiar with topic conceptions.
- The interactive training of technique selection and technique usage.
- The tutoring of the package usage and the executing of procedures for particular task.

Now SIESS is used in two domains: Data Analysis and Network Design.

"Data analysis" is the complexity area which is supported by the different software packages now. Main features of such domain are:

- The large amount of problem situations (PS), any from which demand some decisions about module selection.
- The different factors (may by, correlated) for describe the PS.
- The modules, after which to make decision is necessary again.
- Iteration processes.

"Network design" is outlined now as an independent branch of science and industry with special tuition courses designed in it. This problem area is characterized by variety of methods and means for supporting calculation in networks. There are a lot of "de jure" and "de facto" standards which are continuously updated and complemented by new ones. This creates premises for developing an expert system for tuition in information networks with facilities for dynamic updating.

The problem becomes more complex as it is rather difficult to classify exactly network methods, means and interfaces. In spite of ISO model existing the most of implemented means go beyond the model's frameworks and the methods could be used at the different levels of the model.

The SIESS usage is planned in other topics now.

USING KNOWLEDGE-BASED TRAINERS IN URGENT MEDICINE

OLGA N. DOLININA(*), JURY G. SHWARTZ(**)
(*) Saratov State Technical University, Saratov, Russia
(**) Ambulance et Reanimatology Chair,
Saratov Medical Institute, Saratov, Russia

Keywords: intellectual trainer, model of reanimation situation, semantic net, states, productions, probable outcomes.

There are several spheres of human knowledge where the use of different real-time programs-trainers is vitally needed. One of the typical examples is an urgent situation in medicine, especially, cardiology.

For instance, during primary cardiac arrest in myocardial infarction or sudden heart death the success of the patient's coming to life again can be greatly influenced by the physician's ability to define,diagnose quickly the heart break activity (HBA) type and to put into practice the necessary heart reanimation method (HRM). We must emphasize that seconds can decide the fate of the patient.

Training skills in quick and exact diagnosing and decision - making is extremely difficult in practice and sometimes impossible. In order to solve this problem there was designed a computering tutorial intellectual trainer "Cardiac Arrest".

There are three main HBA types leading to blood circulation failure which can be divided into subtypes. We have 6 varieties of HBA in all.

So the model of the discourse universe can be easily structured.

Physician can use 10 different HRM (physical, pharmacological, electrical) in any order. Under the effect of one HRM or in case of inaction the HBA type can move to either normal state (normal sinusoidal rhythm) or in any other HBA state or it can't be changed at all.

Under the influence of one of the HRM every HBA type has no more than 7 types of outcomes, theoretically. The probability of every type of an outcome depends on HBA character and validity of the chosen HRM.

Besides that, there are some other factors which can influence the outcome: time from the beginning of cardiac arrest, duration of absence of needed measures which has taken place before this affect, type of HBA.

Thus, under the influence of different HRM there are possible repeated changes of HBA states and transition at last to either final outcome A or condition - final outcome B, where

A - biological death,

B - coming to life (stable normal rhythm).

Probability of moving to state B decreases in connection with the time of incorrect physician's tactics. Peculiarity of condition - final state B is that from this state patient can move to intermediate states with heart break activity, again.

For each individual HBA state or for the sequence of states there exists critical time T_k (time of relatively secure patient's being in this state, if TT_k, then patient moves to state A).

For knowledge representation we choose combination of semantic network and productions.

Semantic net represents itself as oriented graph, where evertexes are elements of bounded set of patient's set, arcs - are transitions from one state to another under the influence of different types of HRM. Arcs have probable character so that in accordance with each arc there is probability P_{jk}, where

P_{jk} - probability of moving to state X_k under the influence of HRM M_j realization.

Production system helps to define probability of moving to a new state depending on time value T (patient's being in the state), and also to control the process of decision - making, including changing the states influenced by different external factors and physiological peculiarities of patient. Confide factor is an integral part of each production.

For example, IF HRM: heart massage and HBA state:largewaves fibrillation and there is artificial ventilation of lugs THEN T_k decreases 3 times.

Besides that, the use of production system permits to take into consideration dynamics of states and sequence (chain) of HRM, being used.

For example, IF there was used HRM: input of adrenalin, THEN probability of moving from each HBA state under the influence of every type of electric HRM to state venticular tachycardia increases by 15% and to state assistolia decreases by 15 %.

Tutorial process takes place in real time. There is special timer, counting precious seconds of time needed for patient's saving. Program maximally imitates reanimation situation. You can look at the changes of ECG, patient's face and pupil at the monitor, proceeding from which the physician can diagnose the patient (define the HBA state).

Depending on the physician's experience, speed of time can be slower (for special pedagogic purposes for the beginner the borders of time increase).

Built-in explanation block follows the developing of reanimation situation and if user needs help or in case of transition to states *A* or *B* gives explanations, points out possible mistakes, gives recommendations on further work. Final result can be evaluated by the last state of the patient and by mistakes also (patient can come into life again in spite of incorrect actions of physician and quite the reverse). The system also remembers the process of training (knowledge chaining) for every user.

The trainer can be used in medical colleges, hospitals in order to get experience on the effective medical treatment and assistance in urgent cases. Program is developed for IBM PC XT/AT on CLIPPER-5.01.

THE COMMUNICATIONS PLANNING AND OPERATIVE MANAGEMENT FIELD

I.V. KOTENKO, E.B. DUBRO, D.I. VOYTOVICH
Military Signal Academy
3, Tychorezky prospect, St.-Petersburg, K-64, Russia

Keywords: expert tutoring system, knowledge base, thesaurus, communications networks, instruction methods.

The complexity and dynamics of the global distributed systems which the communications networks belong to, their satiation with the various capability and function mode means and complexes require much from the administrative personnel skills and preparation. To date the required level of specialists preparation can be achieved only as a result of their lasting practical work.

The automatic control systems implementation in the practice of communications planning and operative management aggravates the personnel training problem requiring from it not only the practical skills in work with communication and automation means but the greater explicity in notion apparatus applications, the skills to evaluate the computer proposed decision variants, to prognosticate their realization consequences, etc. The administrative personnel tutoring automation implementing the special expert tutoring system (ETS) of the communications planning and operative management will allow to solve the enumerated problems. The design of the ETS pursues such objects as the knowledge and specialists practical experience transference and preservation, the growth of study motivation at the expense of computer applications and elimination of psychological barrier between pupil and teacher, the individual teaching level increase, the self-study and the tutoring visualization ability and possibility of practical skills training without the real managed objects use. When ETS designing the goals to avoid the traditional tutoring systems intrinsic shortages (the rigid tutoring strategy, the orientation on the middling pupil, the coarse information representation, etc.) were set.

The ETS kernel is the knowledge base (KB) with the model where the communications system thesaurus is taken as a principle. The thesaurus represents the subject domain classification scheme which fixes the composition of the main communication system notions and their stable relations.

Each of the notions is concerned with one of the following classes: objects; characteristics; actions. The reflections of semantic relations between notions in thesaurus are made by the following paradigmatical relation type expressions: synonymous (e.g. communications channel - secondary network channel - CC); hierarchical (type - kind: message - videotelephone message, telegraph message, phototelegraph message; "a part" - "a whole": communications line - communications line section); associative (object-characteristics: telegraph message - urgent category; object - state: communication channel - norm).

The main thesaurus structure element is a vocabulary item composed from the title term (descriptor), the terms connected with the descriptor by the enumerated type relations, also including the notion determining wording, the application examples, the adopted fixed abbreviation, graphical denotion, additional information sources list. Notions concerned with action class are divided into primary actions and secondary actions. The former include actions corresponding to the most detailed commands of the managing personnel. The derived actions are expressed through the corresponding primary actions by the following relation types: "a whole"-"a part", "a process" - "a process stage","a process"-"a realization variant".

Besides the KB for the notions concerned with object class in TSE the norm-inquiry data base (DB) has to be represented including the characteristics of communications means, the description of the service organs composition and capabilities and the "educational" DB describing the structure and state of particular communication data object and the sample variants of the ETS task decisions.

Besides the KB and DB the ETS includes the blocks of user interaction, logic inference (task solver), marks forming and faults diagnostics, modeling of the communications system model changes (in correlation with the pupil decision made), generation (concretization) of the communications system state, education management, realization of pupil model, knowledge acquisition. Except these ETS includes the general system software tools: telecommunication means, audit and access control systems, etc.

The reproductive and problem (searching) instruction methods based on the demonstration, consultation and checking (training) modes are realized in ETS. By the reproductive methods the initial personnel study stage is provided. It consists of the personnel learning and mastering of the basic notions in communications, the structure of communications networks, the capabilities of communications means, etc. The essence of the problem method consists of the particular situation (task) putting and the pupil search of the decision - action variant changing the set managed object state to the proper one.

To date the models of the main named components of ETS have been constructed, the KB structure has been defined and the decision variant forming algorithms according to the tasks have been suggested. The conceptual and logical models of the communications networks DB and its updating algorithms have been designed, the automatic thesaurus variant of the communications system notions is created, the program prototyping of the ETS is performed.

APPLICATION THE NON-VERBAL EXPERT KNOWLEDGE ELICITATION AND PROCESSING SYSTEMS IN THE PRACTICE OF SCHOOL PSYCHOLOGICAL SERVICE

I.P. KOVALYOV, V.V. KRASNOPROSHIN, G.V. GATALSKAYA, H.M. RAZHALOVSKAYA
Computer Centre of Academy of Sciences of Belorussia
Gomel, Belorussia

Keywords: non-verbal expert knowledge, cognitive image, nonmembership function, ultra-fuzzy sets, pedagogical psychology, cognitive image processing system

Researches on design of intelligent (expert, specifically) systems and knowledge base, as their core, have propounded a problem, which has extremely important meaning. It is well-known that expert knowledge formalisms have a non-representational or representational nature. The expert knowledge of first type had been named as the superficial or verbal knowledge, i.e. the knowledge in language form. The other knowledge had been named as the deep or non-verbal knowledge, i.e. the knowledge in cognitive image form. Moreover, a share of non-verbal expert knowledge in the general intellectual resources has been rising as far as development of professional mastery. The non-verbal knowledge formalization and the non-verbal knowledge employment are extremely necessary for working of expert system at present. But, because of substantial nonequivalence of formalized

knowledge to real expert knowledge, existing workings out on overcoming of knowledge non-verbalizing by verbal techniques are extremely unsuccessful. This nonequivalence, as the deep inaccuracy of knowledge semantic transmission and the result on overcoming of representational nature of information by non-representational techniques, leads, practically, to unproductiveness of built expert systems.

Consequently, other approach is spreading for representation and formalization of the non-verbal expert knowledge at the last time, which is based on the cognitive computer graphics techniques and the mathematical apparatus of pattern recognition. This idea and connected with it problems had been expounded in [1]. It is showed ibidem that approach of that kind make possible to solve the problems connected with inaccuracy of non-verbal knowledge formalization well enough, and it enable to build powerful automatic techniques for elicitation and processing of the non-verbal expert knowledge. System of that kind had been called as the cognitive image processing systems by authors. Moreover, as distinct from image analysis expert systems with invariant models (standards) of recognition object, the recognition object models have pronounced subjective nature in the cognitive image processing systems as regards to their getting. The overcoming of information inaccuracy is possible in cognitive image processing systems by two ways : 1) use of *P*-fuzzy set generalization as extension membership function interval to -1 and 2) use not only of membership function of input information, but as well the membership function of models [2].

The first solution introduce into consideration not only input information with the conditional membership function, but as well input information with the conditional non-membership function. In other words, by terms [1], this solution lets consider not only true features of cognitive image with membership function into interval $]0, +1[$, but also false features as true under some conditions. It is necessity for designing of the non-verbal information processing expert systems (the cognitive image processing systems) with generalized recognition object models (standards), i.e. with models from several experts.

The second solution, i.e. introduction of a membership function for recognition object models, allows to eliminate the inaccuracy of knowledge inference. Indeed, for one expert even, elicited subjective models aren't adequacy absolutely and, the more so, this invalidation is being watched for different experts. The fixation of recognition object models as in the image analysis expert systems, i.e. consideration of the model membership function equal only $+1$ or -1 (absolutely true value and absolutely false value), lead to the knowledge inference data corruption in the cognitive image processing systems. The mapping of the membership function space of the cognitive image features (the set $X=\{x_i \mid f(x_i) \in [-1, +1]\}$, $i=1..n$; $f(x_i)$ - a membership function of a cognitive image feature x_i) onto the membership function space of the model set A ($A=\{a_i \mid f(a_i) \in [-1, +1]\}$, $i=1..n$; $f(a_i)$ - a membership function of a model a_i), or the ultrafuzzy set X' ($X'=\{x_i \mid f(a_i)(f(x_i)) \in [-1, +1]\}$, $i=1..n$) as the result of this mapping is the mathematical realization of the sentence of that kind. The features of the got ultrafuzzy sets had been studied and the main algebraic operations had been determined over by them. The mathematical apparatus has been developed, which is being used for solving all of the above-stated cognitive image processing tasks and the task of direct acquisition of the non-verbal expert knowledge.

The theoretical principles, expounded brevity here, have been put into the development of the non-verbal expert knowledge acquisition and organization psychodiagnostics system for the pedagogical psychology sphere with the goal to distinguish the creative intellectual resources and the personality growing problems of pupils.

The system COGNITYPE elicits the non-verbal knowledge of expert-psychologist within two well-known methods in the practice of school psychological service : "House-Tree-Person Test" and "Nonexisting Animal Test", and make the cognitive image processing by accumulation models. The system include three, closely interconnected, subsystems : the subsystem G'MACRO for construction of the macrolanguage graphic primitives, the subsystem NON-VERBALITY for the elicitation recognition object models and direct psychodiagnostics subsystem STROKES (name for system in [1]).

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A FRAMEWORK FOR REPRESENTING CONFLICT RESOLUTION STRATEGIESIN PRODUCTION SYSTEMS

VALERY KRAVCHUCK

ISTRC TECHNOSOFT

44, Prospekt Akademika Glushkova, Kiev, 252207, Ukraine

Email:valera%galagan.ts.kiev.ua@relay.USSR.EU.net

orvalera@galagan.ts.kiev.ua

Keywords: production system, conflict resolution strategies, metarules, metaknowledge.

In any one nonprimitive production system there are several rules or instantiations appliable in current situation. Thus, inference engine have to choose one of them (or limited number of them in multiprocessor implementation) for fireing, e.g. performing their actions. Choosing of the rong rule may cause the infinite computing, nonoptimal solution or large amount of backtracking. Even when exaustive search for all solutions performes, the order of search can be important. One approach to this problem is to write rules according to single standard conflict resolution strategy. Another solution is to describe somehow strategy needed for solving certain task or subtask. Most production systems have some means to deal with this problem: several strategies library, set of filters, which can be combined to get a needed strategy, metarules etc.

Using metarules seems to be most powerfull and flexible approach. A knowledge about which rule is prefareble don't differs greately from domain-specific knowledge, so it can be represented by rules with the same expressive pover. Having a proper representation of the interested rules and instantiations properties you can specify any strategy you need.

Explicit structuring of meta-knowledge allows easy modification and refinement, makes reasoning mechanisms more transparent to the user and provides a basis for stadying problem solving strategies.

One of the main goals of this work was to design intermidiate data structures for abstract representation of domain knowledge relevant properties. These structures are needed to provide information and control links among two levels of knowledge. Special structures can be used even when rules can be completely represented or viewed as data, because the more abstract representation is easy maintenable and understandable. Strategies implemented using such data can be transfered from one system to another.

Sample data structures based on the analysis of information used for conflict resolution by various production systems were elaborated by author for OPS-H [3]. They were extended then for using in other production programming languages. Most of already known strategies were implemented as rule or groupe of rules using these structures. In OPS-like style some of them can be represented as follows

General information about rules:

(l Production

Name rule's name

InCSet is it in the collision set

Priority; rule's priority

CF certainty factor (if needed)

ConditionsNo ; number of conditions

Concrete ; conditional elements number (comparisons with ; constants and binded variables

ActionsNo ; actions number

UsingNo); how many times this rule was used

Information about rules conditions:

(1 Condition

ProdName; rule's name

No ; ordinal number of condition

DataName ; datum used in condition

AttName ; datum attribute

Predicate ; predicate which used in condition

Value ; constant with which attribute is comparing

Type) ; condition type (negative or positive, etc)

These structures can be used as a base for certain system's metaknowledge representation facilities.

Proper metaknowledge using can decrease search space and thus increase the over-all system efficiency. But the main advantage is the ability to represent uniformally a new kind of knowledge, which can be used for tutorial purposes as well as for system's self-modification and self-evaluation.

Knowledge about problem solving strategies is a part of human knowledge used for certain problem solving. As it have been already shown by NEOMYCIN system, explicit structuring of such a knowledge obtained from experts can simplify the process of studying certain domain problem solving principles by students, because it separates factual domain knowledge from domain-specific problem solving methods and well-known general problem solving principles like "Use more concrete knowledge before general one".

Explicit structuring, storing and maintening of expert human knowledge are the main advantagies of expert system technology from the tutorial point of view. A framework been proposed for conflict resolution strategies representation can help to formalize a kind of knowledge, which was weakly structured before and, thus, can be used in tutorial and "conventional" expert systems to increase their expressive power.

For practical use in applications strategies formulated as metaknowledge may be represented as macro-rules. User will be able then to include needed strategy by single instruction like (LEX_strategy). Special macroprocessor for OPS-H were designed and implemented also. Parametrized macroes (macro-rules, macro- conditions and macro-actions) can be used also for domain knowledge representation in forward chaining production systems as a tool for creating new abstractions. Libraries of conflict resolution strategies can be provided for user as include files of macroes.

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THE CREATION OF AUTOMATIC EDUCATIONAL SYSTEM IN MINISTRY OF INTERNAL AFFAIRS

YA. E. LVOVICH(*), V. I. SUMIN(**), A. V. MOGILIOV(***)

(*) Voronezh State Politechnical Institute
Computer Science Department
86, Lenina Str., Voronezh, 394043, Russia
(**) Voronezh High School of the Policy
(***) Voronezh State Teacher Training Institute
E-mail:aspo%vgpi.voronezh.su@techno.fuug.fi

Keywords: expert systems, imitation model, computer assisted learning.

Existing educational systems which are used for teaching specialists in the sphere of guard do not allow to inculcate in skills that are necessary in non- standard situations. From our point of view it's reasonable to create automatic imitation educational models using the following scheme:

- The forming of imitation guard model on the base of system approach.
- The elaboration of information-operation system with block of expert and statistic analysis. The statistic analysis block based on statistic data determines possible tendency of penetration on guard's objects through special constructions. The information about constructive peculiarities of building constructions of each quard object is put into data base. The expert block determines the ways of possible penetrations into object.
- The integration of imitation model and information-operation system which uses real expert and statistic block data in multimedia sphere. Besides there are banks of activities and components of guard activity.
- The expert block appreciation and statistic analysis provide the renovation of data bank and of guard component of automatic educational system.

The dialogue scenary of automatic educational system is made in form of play. This raises the educational aspects.

The automatic imitation educational system based on this scheme is used in Voronzh High School, Karaganda Educational Centre and else where.

INTENSIFICATION OF ECOLOGICAL EDUCATION TRAINING PROCESS USING EXPERT SYSTEMS

S.A. MEL'NICHUK(*), V.I. GRYSKOVA(**)

(*) Ukrainian Institute of Water Management Engineers, Rivne, Ukraine

(**) Glushkov Institute for Cybernetics, Ukrainian Academy of Sciences, Kiev, Ukraine

Ecological education at present has become a constituent element of general system for training engineers. The basis of such education is the task of teaching students skills of practical evaluation of effective measures aimed at improving nature management processes. This is one of major tasks which forms during engineer training principles of environmental protection and of resources preservation activity during implementation and planning of various engineering solutions.

The effect of resources preserving measures is reflected not only in reducing natural resources involved in industrial turn-over (on account of their more comprehensive and full utilization but also of waste recycling) but also in their regulation influence on environment.

The above mentioned tasks are rather complicated.

Their complexity first of all lies in the fact that environmental protection and resources preservation measures embrace all types of economic activity aimed at cutting and liquidating negative anthropogenic influence on environment, at preserving, improving and rational utilization of natural resources potential which includes: construction and exploitation of purification and disinfection facilities, development of low-waste and wasteless technologies and industries, recultivation of lands, measures aimed at fighting soil erosion, at protecting and reproducing flora and fauna, at protecting and rational utilization of mineral resources etc. The above mentioned measures deal with engineering, biological, technological and other solutions.

Taking into account the complexity of calculation and also the informativeness of problems considered we recommend for their study computer technologies. The greatest effectiveness in training has expert training system.

ETS may be conventionally divided info two parts: expert subsystem and teacher subsystem.

Expert-subsystem includes several sections permitting to "take" decisions on a certain nature protecting or resources preserving measure. "Economic" effectiveness of a chosen measure is done by comparing ecological economic results *(R)* with expenditures necessary for their implementation *(S)*. Their net (national economic) effect *(E)* constitutes the increase of average annual national economic result over annual expenditures:

$$E = R - S$$

The value of R is expressed by the amount of prevented damage from polluting the environment and (σr) by cutting losses (worsening quality) of natural resources (W). Here we can also take into account additional effect due to utilizing production wastes and their reuse in national economy*(D)*:

$$R = W + D$$

Correspondingly expenditures on implementing considered measures are defined from the expression: $S = C + Ne * K$, where C is the maintenance cost; Ne is the normative coefficient for capital investment effectiveness; K is capital outlays.

This subsystem includes the following sections:

- The calculation of ecological economic effectiveness of environment protection measures.
- Calculation of polluting water installations by biogenic elements carried away from arable lands.
- The calculation of recreation loading on water reservoir.

- The calculation of effectiveness of other environment protection measures.
- The calculation of ecological economic effectiveness of resources preserving measures and others.

The greater part of expert-subsystem is designed to calculate and forecast environmental pollution. Here major calculations are based on computing maximum permissible concentrations (MPC) of given harmful substances and on subsequent computation of the area of the territory exposed to harmful substances action.

Thus, if the area of the territory studied is S, and the area of its part exposed to pollution is S_1, then the probability of being on a polluted territory staying within S equals:

$P_1 = S_1 / S$.

After defining the law of the distribution of the studied independent random variable and knowing MPC of a given pollutant (X_q) we can determine:

$$P_1 = \int_{X_q}^{+\infty} f(x)\,dx$$

where $f(x)$ is the function of probability density.

The greater part of expert-subsystem is aimed at solving problems in the studied application domain and can itself be an expert system - an ecologist engineer assistant. Its construction is done on expert knowledge taking into consideration that the studied application domain is formalized badly.

In ETS the expert-subsystem is used for working out the standard solution of the problem which is set as an example to the trainee. This answer is then compared with the trainee answer.

The teacher-subsystem is a sort of training superstructure over the expert system itself. Such superstructure conditionally consists of several parts:

- "Planner" of training.
- Information part of training.
- Part used for training control.
- Part generating exercises for comprehensive checking up the trainee.

Planner" of training does the process of planning training on the base of the available study material formalizing the knowledge of methodologist on methods of training. The trainee is given at first the theoretical part on a problem chosen by him. If something in the material proposed to him turns out to be not clear enough he may "scan" the suggested material. For this purpose on the base of chosen key words the material is supplemented by more detailed explanations.

At the end of each section the trainee is proposed control questions and also control tasks. After obtaining solutions from the trainee they are compared with solutions received by the system. If on comparison there are found essential differences then on their base the system tries to establish what wrong ideas of the trainee on ecology could lead to differences obtained. In the result of diagnosis tasks which are later proposed to the trainee are defined more exactly.

Besides, on the base of analyzing mistakes the system deciphers the mistakes essence and points out at possible ways of their correction. Then the system customer again tries the given task taking into account helps. During such a "dialogue" the statistics of addressing the system is registered which later is taken into account during setting next task to the trainee.

All mentioned earlier four parts of the teacher-subsystem interact with each other under the guidance of the "planner" of training.

In the structure of ETS two knowledge bases can be conditionally distinguished: the base of specialist knowledge and the training knowledge base.

The latter in its turn consists of: training knowledge base on ecology, training model, the base of knowledge of possible trainee mistakes.

The customer's base of knowledge of possible mistakes makes use of the probabilistic approach to knowledge representation. This is dictated by the fact that it is possible to surmise over possible mistakes of the trainee with a certain degree of probability as is the case with his knowledge. During training the system sort of "adapts" to the trainee taking into consideration his answers to questions and tasks put by the system.

Let us point out that the probabilistic approach is used not only in this KB but also in other KB. For example, if the event *B* - pollution of a river by industrial wastes, the event *C* - its pollution by agricultural wastes and *S* - the complete event system then this set part is proportional to the probability that the river is not polluted at all. Then the probability of the fact that the river polluted by an industrial waste will be polluted also by an agricultural waste will be determined as a conditional probability by a Beyes formula.

ETS allows to organize the consultation on a certain object of calculation. Before the dialogue start the student points out at those attributes which are of interest for him as the object of consultation. Revealing contradictions in initial data staff possibilities of the system allow to return the dialogue start and to change certain answers.

The explanation subsystem allows to demonstrate to a student cause-consequence relations emerging during the consultation. Due to the fact that the reasoning process is rather ramified ETS gives the opportunity to control the examination. This admits transfer from premises to consequences and vice versa. At each step of its functioning the explanation subsystem shows the particular state of this or that BK module.

ETS on ecology is an open system. It can be supplemented as the supplement to knowledge base and as an extension of the trainee model, i.e. as a supplement of a new network of states which is put into for each section of the subject.

ETS will help teachers at different stages of training both for study process itself and for controlling student knowledge. This system in its turn will help students to exercise analysis, to forecast development and also to suggest ways of optimizing the solution of particular ecological situations. This will help automatic various forms of training activity, make study diversified and inqividualized which will essentially intensify the study process.

INTEGRATION OF EDUCATIONAL CRITERIA AND MULTI-EXPERTS USING A KOD/BOOCH APPROACH

VALERIE MONFORT

IDLS 1 - LICIAP 2 Institut Des Logiciels et des Systemes,
Chambre de Commerce et d' Industrie de Bayonne Pays Basque,
50-51 allees Marines BP 215 64102 Bayonne, France
Laboratoire d' Informatique, Communication, Intelligence Artificielle, Pedagogie ,
IUT de Bayonne, 3 ave J. Darrigrand 64100 Bayonne, France

The fishing trade is constantly technologically advancing. In fact, the fishermen are confronted with the problems of costs and profitability although resources of fish are becoming rarer and rarer. In response to the need for the maritime schools, we are developing a simulator allowing students to learn both the navigation and the fishing trade thus improving their performance. The performance is carried out according to three fundamental axes :

- Putting the navigation and fishing techniques into practice using real time.
- Considering the boat as a true enterprise to be manage.
- Respecting fish resources.

These three aspects make the fishing simulator an innovative tool responding to the expectation of professional fishermen. This project is a veritable melting pot of advanced technologies since it requires the following techniques :

- Synthesis of images using Silicon Graphics.
- Communication using a network.
- Vocal Synthesis.
- Extraction and design of knowledge.
- Object Oriented design and programming.

Firstly we shall broadly describe knowledge acquisition with KOD (Knowledge Oriented Design) of C. Vogel [VOGE89] and how we have integrated this collection within an educational context. Then, we will show how we have structured and designed the collected information with the help of Booch's object oriented method.

1. ACQUISITION OF KNOWLEDGE AND EDUCATION

We present here the coupling between the KOD method enriched by new concepts linked to the project and the design of the collected knowledge with the help of an object oriented method.

1.1. Extraction of knowledge using KOD

At first, our main objective was to gather the experts' know-how. For a realistic simulation we questioned professional fishermen firstly on land and then at sea to observe all of the aspects of their work. These experts are of different levels with many capacities. They are all proven sailors, mechanics and fishermen. The expertise allows the simulator to judge little by little the behaviour of the students at sea faced with difficult situations.

According to J.L. Ermine in [ERMI93], KOD does not look to include the complete life cycle of a knowledge based system, but it is essentially oriented towards specification. It is a structured method which uses both the techniques to carry it out (interviews, collection of expertise ...) and sophisticated theoretical representations, heavily impregnated of human sciences like anthropology and linguistics.

We present the three level of the method : static, dynamic and thematic.

- At a static level : for our application we have identified the objects extracted from the expert's speaking and the actions applied upon these objects which transform their state. We have gathered these objects called "taxemes" and these actions in clusters of problems or "themes". We have built hierarchies. For instance, for the beacon we have : "cardinal beacons, isolated danger beacons and healthy water beacons are kinds of beacons". A beacon is caractrised by a particular shape, a colour and a rhythm.
- At a dynamic level, we have described the actions "actemes" which are the representations of state changes of a taxeme. A representation using SADT (Structured Analysis Design and Techniques) diagrams [IGL89] usually allows the user to show the structured actemes in "actinomies".
- At a thematical or declarative level we give a sense or a theme to the state transformations described on the study field. For instance : "to find the beacon by watching the radar, to position oneself with the beacon, to go on the righthand, to go far away by watching the radar".

The aim of fishing simulator is educational. We had to take into consideration this context by integrating the experts' knowledges, those of the educators and those of the students (level of knowledge). This following paragraph expands the taking into account of various sources of knowledge.

1.2. Educational aspects

We tried to extract the educational interest to teach to the future fishermen who prepare their exams over two years. In fact, teachers opted for a superficial teaching of mechanics knowing that each fisherman is helped in reality by his mate, a mechanic. It is not necessary going on in more detail the knowledge acquisition concerning the mechanical part. The director of the maritime school, a teacher and an former fisherman, with whom we are in contact, even agreed to play the role of a mediator when conflicts between experts occurred.

Furthermore, the students are of different levels : first year, second year, continuing education with professional experiment, etc. We adopted to choose efficiency levels between students according to a basic profile, help, different adapted interfaces.

The used architecture is multi-agents. In fact, the students' computers can communicate via a network and are supervised by the teacher's computer. Each student, a knowledge source, can see on his screen his neighbour and can even fish with him, because fishing techniques exist with two boats. The teacher boat sends a set of events in real time or in differed time (by preparing the lesson) to complicate the lesson and to test the speed of the students' success faced with difficult situations.

The following paragraph shows the approach we have chosen to design the acquired knowledge.

2. USING BOOCH'S METHOD

Software engineering offers a certain number of object oriented methods such as Hood [HOOD91][HEIT92], OMT [RUM91], Coad/Yourdon [COAD90], Shlaer/Mellor [SHLA88], Wirfs-Brock [WIRF90], Booch [BOOC91][BOOC92] ... At first, we have chosen a method which adapts to the constraints imposed by the application using the real time aspect, the design of dynamics, a vast hierarchy of objects, the ability to re-use the design and the generated code.

The first time, our study drove us to research qualitative criteria to compare the methods and to choose between them. We were able to classify the methods according to several aspects :

- Taking into consideration of the life cycle of one application : in fact some methods such as OMT or Wirfs-Brock adopt analysis and design steps although some methods such as Hood or Booch are more design methods.
- The design of dynamics is perceived differently according to the chosen method. We can precise that each method specifies the behaviour of objects, if necessary, by using SA (Structured Analysis). The Hood and Booch semantic, for instance, allows us to represent synchronous, asynchronous, with delay .sendings messages. The active object concept of Hood and Booch allows to represent the parallelism. Furthermore, to show the evolution of the system, these methods call up state-transition automatons.
- The structure of the clusters presents similarity from one method to an other. Each method use the notion of encapsulation. The most characteristic semantic links are : the inheritance, the composition with cardinalities, messages sent with cardinalities.
- The kind of implementation is a criteria which can occur in the choice of one method. Some methods insist on the structuration into hierarchical clusters and so seem more adapted for object oriented or relational data based applications. In fact, some methods such as Shlaer and Mellor or OMT allow a rapid passage to the relational model and the normalisation in third BCNF. Methods as Booch or Hood insist on dynamics and enable you allow best represent real time semantics. Furthermore, these methods are conceptual and very close to implementation. In fact, Booch offers a rapid passage to C++ and Hood to ADA.

We had to choose an "ideal" method and we adopted a composite method in [MONF93a] and [MONF93b]. In conclusion, from our deep study , we are certain that Booch is the most adapted method for a coupling with KOD.

3. CONCLUSION

Our perspectives of research are numerous. They first consist of focussing us on the multi-agents and on the incertain or approximative integration of knowledge. We foresee re-using, with the KOD/Booch approach, knowledge acquisition, the design and the generated code to be able to create other kinds of simulator.

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AN APPROACH FOR KNOWLEDGEABLE BASIS CREATION IN THE INTERDISCIPLINARY EDUCATIONAL PROGRAM MEANS DEVELOPMENT PROCESS

IRINA J. NIKONOVA
Institute of Applied Informatics
12/191,Ushakova Str., Kiev, 252179, Ukraine

Keywords: knowledge, knowledgeable basis, experts, texts, content analysis

The development of educational activity support systems needs the integrated knowledgeable basis creation that is projected into the peculiarity of computer technology and peculiarity and requirements of perspective student users.

The need for making use of knowledges related to the different subject area conducts to the necessity of drawing experts from different subject areas into the process of program means development.

However, as experience shows, the effective collaboration of different specialists while inter-disciplinary work is often prevented by the absence of common understanding among them, the

difficulties in obtaining, interpretation and integration of necessary knowledges needed for decision making.

The aim of current work is the development of an approach to the extraction of all appropriate for decision making support knowledges.

A proposed approach is based on the investigation conduction of individual inner representations of world fragments that is related to the current problem context.

It is proposed to make the investigation of knowledge structures on the base of revealing of individual concepts and their interconnections.

It is proposed to use the language activity products (texts in written and/or oral forms) as target material.

It is developed the iterative process of getting of the texts and of their analysis. The type of analysis varies from low structured method of text information collection (selection of already existing texts, low structured interview) in the early stages of investigation up to the structured method of questioning.

The processing of obtained texts is proposed to make by the method of content analysis.

An analysis of contexts of elements of resulting extracts, comparison of different extracts is conducted for the purpose of investigation of the degree of separate concepts of different experts are been formed, for determining the "holes" in their notions and existence of conflicted notions. The results of such an analysis is determined the directions of structured questioning conduction.

The proposed procedure is quite laborious but easy automatized. The frame of this automatization procedure is vocabulary free automatic morphological analysis, procedure of selection and occurrence frequency counting, statistic procedures for data investigation.

Obtained data are to be used while collective activity organization and as knowledgeable basis of developing program means.

APPLICATION OF PROBLEM SOLVING EXPERT SYSTEM IN EDUCATION

H. PETKOV
Department of Artificial Intelligence,
Institute of Informatics, Bulgarian Academy of Sciences
29A, Acad. G.Bonchev Str., 1113 Sofia, Bulgaria
E-mail: ari@iinf.bg

Keywords: intelligent tutoring systems; problem solving; teaching methods; analytic reasoning; goal-directed asking.

This paper is based on an experimental teaching expert called TET (Teaching Expert over TRIPS- TRIgonometry Problem Solver). TET supports multiple teaching strategies and methods and is intended to work with the domain expert system TRIPS operating in a constrained class of mathematical knowledge - high school trigonometry. The experimental couple TRIPS - TET is intended for use in an overall Intelligent Tutoring System (ITS) with an open, multiexpert architecture. For a good discussion of multiexpert conceptualization of ITS see [1] for example.The acceptance of a similar approach provides the opportunities to experiment with different teaching modules, implementing previous design solutions or parts of them.

The domain expert TRIPS is based on a hierarchical formal model of procedural conceptualization of the domain, presented below:

$S=\{S_1,S_2,...,S_k,\}$, $S_i=\{M_1,M_2,...,M_l\}, i=1,k;$

$M=\{M_{11},M_{12},...M_{kl}\}, M_{ij}=\{O_1,O_2,...,O_m\}, i=1,k;\ j=1,l;$

$O=\{O_{111},O_{112},...,O_{klm}\}, O_{ijs}=\{R_1,R_2,....R_p\}, i=1,k;\ j=1,l;\ s=1,m;$

where S is the set of strategies for searching and choosing an appropriate method to solve a domain problem, and consists of a set of methods l and rules for their application; M is the set of all possible methods for solving a domain problem, and each method consists of a set of operators, m in number, and a set of rules for their application; O is the set of all possible operators, able to cause transition (steps) in search, where each of the operators consists of a collection of rewrite rules R, p in number and rules for their application as processing procedures. The strategies, methods, operators and the rewrite rules put together form the procedural knowledge (the knowledge, needed for processing and inference) and are described in details in [2] and [3].

The inferences, drawn by the Domain Expert are called solutions and the index record of the procedural concepts applied at each step - justifications. The Teaching Expert coupled to TRIPS - TET uses the solutions and their justifications and applies different teaching strategies over them. Special domain dependent metrics for heuristic evaluation of the solutions has been developed. The metric values at each step are recorded in the justifications.

TRIPS serves the following roles in this overall system:

- It solves the problem step by step.
- Records the inference of the solution explicitly.
- Provides multiple solutions of a problem.
- Supplies explanations.
- It works as a cash for all the inferences made over a given domain problem.

TET is based on similar procedural conceptualization as TRIPS. TET uses teaching methods to present the the material of the problem domain. At present it has been experimented with analysis and the goal-directed asking, described in details in [4]. The analytical method implements analogical reasoning, in the sense of [5], and some additional constraints.

The formalization of the two teaching methods is a pragmatic one and does not pretend to represent fully and in depth the behavior of real-world human teacher. It could be viewed rather as a functional approximation of these methods. They are developed in the form of tests with teaching feedback, which proved to be the most convenient form for the machine representation.

As a whole the conceptualization of TET is based on a modular approach with open architecture, where new teaching methods could be added and the existing ones easily could be refined and modified, mainly in respect with future research work.

The formal model of the teaching expert contains different teaching methods (analytic method, brain attack, successive refinement, discovery learning and assessment, cognitive apprenticeship, goal-directed asking etc.) that are to be chosen and applied by TET. The problem of selecting a suitable teaching method proved to be a hard nut to crack. The research with this is foregoing, and was not done yet mainly because choosing specific teaching method is a very precise cognitive task imposing top level teaching expertise and classification of student behavior.

The contributions of TET are:

- Conceptualization of a teaching expert with open architecture.
- Developing an approach for computer implementation of purely theoretical teaching methods.
- Integrating different types of knowledge (teaching and domain expertise) into a uniform model by building up compatibility techniques.

A more specific contribution is the development of knowledge bases for representation of the conceptualized knowledge in a logic programming environment.

TRIPS and TET have been experimented in ZPROLOG v. 5.0, a product of the Institute of Informatics. A 3.5" disk with the experimental simulations of the system on IBM-PC/MS-DOS is available on request.

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INTELLIGENT TUTORING SYSTEM FOR PROOF BUILDING EXERCISES

REIN PRANK

Department of Computer Science ,Tartu University

2, Liivi Str., EE2400 Tartu, Estonia

E-mail: prank@csd.ut.ee

A teaching software project for the Basic Course on Mathematical Logic for the first-year students was started in Tartu University at the end of 1987. At present stage we use four programs covering most of the exercises of this course (truth-table exercises, formula manipulation, formal proofs, Turing machines) [1]. Beginning from 1991 the students have computer time for independent work. For example each of them has to build about 40 proofs in Propositional and about 40 in Predicate Calculus.

First two programs have had Expert Hint facilities from the begin. In 1993 we have added Propositional Prover (written by the second author) to PROOF EDITOR.

PROOF EDITOR is a tool for building on the screen the proofs in Gentzen Type Calculus with following propositional rules:

$$\frac{\gamma \models A;\ \gamma \models B}{\gamma \models A \,\&\, B};\quad \frac{\gamma, A, B \models C}{\gamma, A \,\&\, B \models C};\quad \frac{\gamma \models A}{\gamma \models A \vee B};\quad \frac{\gamma \models B}{\gamma \models A \vee B}$$

$$\frac{\gamma, A \models C;\ \gamma, B \models C}{\gamma, A \vee B \models C};\quad \frac{\gamma, A \models B}{\gamma \models A \to B};\quad \frac{\gamma \models A;\ \gamma \models A \to B}{\gamma \models B}$$

$$\frac{\gamma, A \models B;\ \gamma, A \models \neg B}{\gamma \models \neg A};\quad \frac{\gamma \models \neg\neg A}{\gamma \models A};\quad \frac{\gamma \models A}{\gamma, B \models A};\quad \frac{\gamma, A, \Delta \models B}{\gamma, A \models B}$$

The proofs are built in the form of the tree from the root upwards (from the sequent to be proved to the axioms). At any step the student has to select an inference rule from the menu. The program checks if the application of this rule is possible. If not, the corresponding message is given. Otherwise the upper sequent(s) of the rule is (are) added to the tree. If the upper part of the rule

contains a new formula, the student has to enter it. The program checks when the proof is complete. The proofs (completed or not) can be saved to file, loaded from file or printed.

The student can use the Expert Hint of the PROVER in two forms:

- Asking hint for the next step (choice of the rule or the new formula to be entered).
- When the student has completed the proof, it will be compared with the proof created by the PROVER. If the last is shorter, the program indicates the first inefficient step in the tree and proposes to rebuild corresponding subproof.

The PROVER works with sufficient speed. For any problem from our exercise files the reaction time is smaller than one second.

The possibility, to get the hints, has caused some overuse problems with the weakest students. For creating some pressure our program puts 'solved' in the file of the results only when the task was solved without hints, i.e. after using the hint the student has to solve the same task once more.

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STUDY AND APPLICATIONS OF EXPERT SYSTEMS IN AN EDUCATIONAL PROCESS OF A SECONDARY SCHOOL

JURY S. RAMSKIY, NADIYA R. BALYK
Kiev State Pedagogical Institute
9, Pirogov str., 252030, Kiev, Ukraine

The computerization of education is associated with sufficiently important directions of modern technology development. Today the attempts of extending a computer potential are concentrated on a creature of artificial intelligence. Some artificial intelligence programs, particularly expert systems (ES) are widely used at various branches of activity including a teaching practice. But now advantages of ES in education are not realized in full measure. Therefore the problems of studying ES at course "Foundations of information technologies and computers" and investigating a pedagogical appropriateness and effectiveness of their applications in an educational process are actual.We made a study, which learned a state of a presentation of the mentioned above course at a secondary schools and schools with a deeper study of mathematics. Our observation showed that using ES in an education is in a starting stage. The methods of studying ES are absent. In 1993 a searched stage of the experiment was started in which the selection of contents of the topic "Expert systems" is realized and also the selection of instrumental tools for a creation of ES. Methods of studying ES are given too. All these problems are solved in the process of presentation of the mentioned them at the Ternopol Physical and Mathematical Lyceum. The theme includes the acquaintance with principal notions of ES, bayesian statistics method of decision-making, ES development methodology, using instrumental system BESS. Studying these problems needs acquaintance with initial notions of probability theory and main probability principals. We have constructed a program of a special course "Elements of the probability theory and mathematical statistics.", that is studied before the consideration of ES. Thus, ES are represented as an integrating origin between mathematics and informatics and other scientific subjects. In order to construct an own knowledge base it is necessary not only to reproduce a studied material from a subject area but also to develop it creatively. Namely, it is necessary to formulate a problem, to make a search and selection of data for it, to select symptoms and hypotheses by description of the aim of the problem, to determine a connection between them, to estimate a priori probability of every hypothesis, to count posterior and a posterior probabilities for the symptoms. The tasks on the construction a knowledge base open a wide possibilities for using ES in many school subjects, as an effective mean

for systematization and generalization of pupils' knowledge, for activation of their perceptual activity.

During the experiment the teaching effectiveness of ES is investigated that is based on various models of knowledge representation. The ES shell is constructed in which the knowledge is represented as frames giving a possibility to systematize a teaching material and to classify it. The previous results of the experiment showed a high effectiveness of using ES in auxiliary courses and also knowledge systematization and generalization lessons, hence, appropriateness of the developed special course.

ON NEW AUTOMATIZED PROBLEM DOMAIN KNOWLEDGE ACQUISITION METHODOLOGY ON THE BASIS OF COGNITIVE MODELS

EKATHERINA SOLOVYOVA, SERGEY MATORIN, PAVLO PAVLOV, VALERY EVTIKHEEV & GENNADY MIKHAILIK
6, Krimska str., Apt. #73, Kharkiv 310166, Ukraine

Keywords: knowledge acquisition; knowledge-based computer-aided instruction systems; systemological cognitive methodology; poor-structured problem domains; multi-aspect and natural classifications; system of terms; hypertextual conceptual structures; systemology; natural classification criteria; essential functional properties.

A new methodology of conceptual natural language knowledge acquisition for a poor-structured problem domain is suggested. A set of systemological cognitive methods, mathematical models and software tools for automatized knowledge acquisition on the basis of exposing of cognitive structure regularities are developed.

The suggested software tools may be used as basis for knowledge-based computer-aided instruction systems and for learning basic concepts and system of terms in any application domain. It also may be used to automate the building, analysis and estimating multi-aspect (goal-oriented) and natural classifications, with respect to essential properties of objects.

The software tool kit includes means for hypertextual structure of concepts visualization, and means for building user-friendly interface with the voice information output, enabling one to take into account psychological aspects of learning and dialogue in different modes.

The presented methodology is based on new research results in the system-class systemology and results of cognitive research of reflections of the 'picture of the world' in human consciousness and sense of tense. A set of conceptual system regularities is presented and described mathematically. Structuring of properties and natural classification criteria are also taking into consideration.

The following is shown:

- The structure of reality (problem domain) considering essential properties (or in a definite way) is hierarchical. The conceptual classification also has a hierarchical structure that corresponds to the reality.
- Concept's content reflects essential functional properties of system in the supersystem and concept's volume - supporting properties of the system. Meanwhile the supersystem is reflected in the generic concept , the subsystem is in the species concept , essential functional properties of the system - in species varieties of the concept.
- Genus'-species classification of essential functional property-class concept defines genus-species system-class classification of concepts that posses the properties.
- Essential supporting properties of a system are essential properties of its subsystems and species of its essential functional property. Concepts of essential system supporting

properties are concepts of essential properties of its subsystems of essential system functional property species.

For the first time the main criterium of natural classification is formalized:

- Let S_i be a system-class of the i-th level (21 , where m is a concrete system level, if i =1 it is the supersystem) that has an essential functional property S_{pi}. Let S_{i1} , ... , S_{in} be subsystem of S_i , and S_{pi1} , ... , S_{pin} are essential functional properties of subsystems. Than above-mentioned is equivalent to the statement that S_{pi1} , ... , S_{pin} - essentional functional properties of subsystem Spi and supporting properties of the system Si.
- Let C_i be a concept on a system-class S_i of the i-th level (21 , where m is a level of unit concept , if i = 1 it is a category) the species variation of which is C_{pi} that reflects essentional system functional properties. Let C_{i1} , ... , C_{in} be species of the concept C_i that reflect subsystems S_{i1}, ... , S_{in}, and C_{pi1}, ..., C_{pin} species variations of the concepts C_{i1}, ... , C_{in} respectively that reflect essential functional properties of subsystems. In a natural classification of concepts it is possible if C_{pi1}, ... ,C_{pin} are species of the concept C_{pi} and properties of the system S_i.

The proposed mathematical models and software tools may be utilized as components of expert systems, design-automation and teaching systems for acquisition and representation of knowledge on any problem domains, including the poor-structured ones.

KNOWLEDGE REPRESENTATION FOR TRAINING GAME ENVIRONMENT BASED ON THE NEURAL NETWORKS

ALEXANDER STRIZHAK, VICTOR TYUTYUNOV & VICTORIYA SHTURMOVA
Glushkov Institute for Cybernetics, Ukrainian Academy of Sciences
40, Prospect Akademika Glushkova 252207 Kiev, Ukraine

Keywords: problem domain, elements of described knowledge, neural networks, neural field, neural ensemble, neural network learning, thesaurus, training games.

In modern sense student's cognitive activity is one of the main aspects in the educational process. It includes two large problems:

- To develop the problem domain's knowledge bases.
- To evaluate the aids for adaptive representation of the processes and occurrences under investigation.

Authors propose the techniques and means for creation training game environment based on the neural networks representation of the problem domain and pedagogical problem activity, for transformation the elements of the described knowledge into various forms and models for the display of the problem domain's state.

The designing of the training knowledge-based systems depends on the use of the associative-projective neural networks (AP - neural networks), which consists of the neural fields and neural bonds between such fields.

Neural field is a subset of neurons, which have the identical activities. Every neural field have an equal number of neurons. There are a few types of neural fields: associative field, buffer field and others.

Associative field is meant for generation of the neural ensembles during neural network learning process and associative recognition of the ensembles during the network working mode. Buffer fields are necessary for acquisition, temporary storing and normalization of ensemble's dimensions.

The main rules for set up the neural bonds:

- Associative bonds exist only within the associative field.
- Neural fields (associative, buffer and others) is connected with projective bonds.
- The weights of the bonds have binary value (1 if bond exists, 0 otherwise).

Projective bonds establish the one-to-one correspondence between neurons of the two fields. They are not changed during neural learning. There are braking projective fields in the AP- neural networks.

Associative bonds serves for generation of the ensembles within the associative field. Bond's weights are changed during learning according with the Hebb rule.

Neural ensemble is the main information element in the building up of the knowledge base. It is a subset of neurons of the associated field, which are connected with exciting bonds. Neural ensemble may corresponds to the description of the object,the description of the situation,the description of relation between objects.

Neural ensemble's properties:

- If part of ensemble is excited then the full ensemble will be excited.
- Only a part of ensemble's neurons of the low layer will be included in the ensemble in next layer.

Neural ensemble's operations:

- Generation of the neural ensemble. It takes place within the associative field during neural network learning by means of changing of the associated bonds between neurons; neural ensemble in the next layer consists of the parts of the ensembles of the lower layers.
- Normalization of the neural ensembles. It is a rule for selection of the part of low-layer ensemble's neurons for generation next-layer ensemble.

Knowledge-based system engineering of the problem domain includes:

- Development of the thesaurus, which consists of the basic concepts of the problem domain and ordered set of the relations between objects. There are few types of relations in thesaurus: hierarchical type (classification) and nonhierarchical (associated, synonymy, antonymy). The representation of thesaurus is an oriented graph.

The transformation of the elements of described knowledge in the neural network environment is realized in such way:

- To add to the learned neural network new layer. It will describe bonds between objects and graphic images and will mean for representation of the states of problem domain.
- To select the scripts for interaction based on the thesaurus (compositions of objects and processes); aims for training activity should be created and fixed.
- To form the game's modes as development of the interaction's scripts.

Software described in this report includes:

- Neural network emulator.
- Graphic processor for generation of the two-dimensional and three-dimensional models based on as vector so bit-mapped graphics.
- System for building multi-dimensional thesaurus.
- Means for development of the multi-windows interface.

- Interpreter for database's schemes.

Software was developed on the IBM PC/386.

INTEGRATION OF EXPERT BUILDER IN TRAINING COURSES

JASIM M. THIAB, BOIKO ANGELOV, IVAN PANKOF
Computer Education Lab
Technical University, Sofia, Bulgaria

This paper present the use of expert builder as a powerful tool in training courses for the freshman student with some knowledge of the IBM PC. Implementation of such system is adequate to the education goals, because expert builder provide a new tool for qualitative modelling. This program can be used in a range of curriculum areas, including science, the humanities, math and technology. Most student seem to become adopt in manipulating the user interface within a half hour. Expert builder provides the facility to construct much larger models with several hundred boxes so that student could undertake a more complex modelling building task as a project. Expert builder has encourage student in the training course to think on deeply on model building process, although modelling activities which student has undertaken are quite limited and simple, but these enable student to develop some more limited modelling expertise.

THE PEDAGOGICAL SOFTWARE COMPUTER-AIDED DESIGN SYSTEM (PS CAD) WITH ARTIFICIAL INTELLIGENCE FOR SCHOOLS AND TEACHER-TRAINING COLLEGES

V.M .ZELENIN, L.A. KEROV
Russian State Pedagogical University
48, Reki Moiki emb., 191186, St.Petersburg, Russia

PS CAD is intended for the creation of the educational programs such as the teaching programs, the training programs, the demonstrating programs and the inquiry programs using IBM PC or compatible computers. The designers and the users of the programs created into the PS CAD environment are the schoolboys, the subject teachers and the students of the teacher-training colleges who are not programmers.

The basic idea of the educational programs design method into the PS CAD environment is the preliminary creation of the shells of the various types' programs. In these programs are reserved some areas to include the school materials for the concrete subjects of the classes and a game component from the library of the games. The didactic materials are prepared in a natural language and they are included into the shell of the program by means of the keyboard. It does not demand any special knowledge or any special technique and increases the productivity of labour in 15 - 20 times as compared with the hand programming.

The creation of the pedagogical software for schools is the good means for the problem training, for the collective learning and for the production activities during the study of the informatics and other school subjects. During the creation of the software the teacher plays the adviser and the consultant. The schoolboys or the students play the immediate performers. The understanding of this work's profit for their school, the passion of this work and the possibilities for the creative development are the good motivations for the learning as the informatics as the other school subjects for which the pedagogical software is created.

The ideas of the individual and differential approaches to the teaching may be easy realized in the training programs and in testing programs. Such programs made into the PS CAD environment

allow to carry out the training in the game environment. It attracts the attention of the schoolboys. It liberates the teacher from the routine part of his work by means of the using of the programs adaptation methods and by means of the using of the computer aided marking with elements of the artificial intelligence.

Now the general level of the informatics is such that the artificial intelligence systems begin to find their practical applications. The programming language based on the logic (Prolog) is being studied now in many schools. The time comes to use in the teaching some training programs of the expert type. In PS CAD are realized many modern requirements of the pedagogics and of the psychology to change the contents and the methods of the teaching in order to develop at the schoolboys and at the students the abilities and the skills for the independent active learning

The creation of the expert system by means of the PS CAD may be imagined in such a way. The teacher asks for the schoolboys to present the obtained knowledge in the form of the production rules:

IF the signs of the objects or of the phenomenon

THEN the description or the drawing or the action

or the formula

During the lesson those rules are put into the program named the shell of the expert system. The full program is the acting model of the artificial intelligence system used in the science, in the technique, in the medicine and so on. This work give to the schoolboys and to the students the skill for the independent activity.

UNIVERSAL EDUCATIONAL SIMULATOR : PRINCIPLES CONTROLABILITY, EXPERIENCE OF USE

N.E. BAEVA, T.V. AZARNOVA
Voronezh State University
96, Holzunov str., apt. #332
Voronezh, Russia

A prospective mean for considerable increase of the education quality is the use of Universal educational simulators (UES). The term UES implies functionally complete set of programs considered as a whole and providing solution of problems in exercising of stable skills and abilities in the narrow specific field. Modern UES are complex applied program systems allowing to automate human intellectual activity while solving non-standard problems which are usually poorly formalized. UES are developed basing on system approach with the account of advances in the field of artificial intelligence systems, in data and knowledge bases, new technologies of programming.

For a number of years the authors actively work in development and use in the educational process of specialists in the field of applied mathematics of the UES - elaborator of mathematical models of economic and manufacturing processes. Analysis of traditional methods of education of the students in mathematical modelling has led us to understanding of the fact that due to exhausting and sometimes a little meaningless numerical calculations the students do not attain the goal of the knowledge actualization in the necessary subject field in proper time, they can not solve problems in mathematical modelling and adjacent issues in sense, clearly choosing and rightly accenting the main properties and characteristics of the fragments of typical economic situations suggested for education.

The development of clever, well-thought, broad system of computer support of realization of the main stages in mathematical modelling (study of the object of modelling, design of the model, preparation of original data, elaboration of numerical calculations, validation and verification of the model) - allows not only to improve the quality of training for applied mathematics in this field but also to perfect their skills in system analysis of the processes, their ability to use computer, to develop creative intuition while choosing the ways of realization of the stages requiring a lot of intellectual work, etc.

The nucleus of UES designer for mathematical models is applied program batch realizing with a computer some methods of linear and non-linear optimization : solution of problems of special structure (development and arrangement of production, interbranch balance, parametrical programing), methods of correction of inaccuracies in the statement of broad range of applied problems. It is called as Solver.

In our report it is assumed to consider the general structure of the Solver and its components: input languages of object and system software. Quality indexes defining functional opportunities and structural properties of Solver are considered as well: calculation accuracy, time of work, resources used, organization of diagnostics, the necessary qualification of user, etc.

Solver structure is considerably determined by requirements of applied programs batches realizing the other stages of modelling, first of all, class of identification, kind, type, structure and composition of mathematical models descriptors. This stage is realized in UES in the form of Universal model-designer. Principles of design and educational opportunities of this unit will be considered in the report.

Here we note that the concept of model-designer is based on structure modelling which is considered as a process of integration of the simplest models in the composite by their structure and the character of internal interactions complexes and the ways of directed arrangement of individual models of typical economic objects of the system. Design of new models is made step by step. The algorithm of design of complex objects is formulated in terms of conditions and events. The event is treated either as a compiler (user) action or as Model-designer action. Model-designer actions are realized in the scriptor approach allowing to connect each event with two types of conditions displaying the event state: a) readiness condition expressing what must be done in order the event to

occur; b) completion condition expressing what should occur after event. Integration algorithm of the model of complex object is treated as the motion along the tree which is a synthesis of actions tree, aims tree and states tree of the trained person and Model-designer.

Design and adoption of the structure modelling technology is based on realization of the following components:

- Allocation of the field for structure modelling in the considered subject area.
- Allocation of rules and principles of formation of basic versions of configuration (arrangement) for the reference units of field into complexes simulating the object of modelling (original) with an acceptable similarity.
- Formation on the basis of those rules and principles from the reference field units of the possible variants of models for considered original $M = \{ M_1, M_2, M_3, \ldots, M_K \}$ where M_K is k -th variant of the model; M is a set of variants realizing on the basis of use of configuration scripts and check procedures of the formed complexes on admissibility.
- Separation of the set of M models the best one in the sense attributed previously. In other words, realization of the problem of accepting decision considered as cortege $G = < M, Q >$ where Q is optimation principle representing quality of variants (for example, the rule of variants preference). Solution of this problem is reduced in fact to the separation of properties a_i ($i = 1, \ldots, n$) used for variants estimation, determination of the set of its states A_i, separation of basic properties B_i off the set of states B_j, writing of the problem of accepting decision as a system in terms of generalized variables and the choice of representation $f: M \rightarrow V$, where $V = V_1 * V_2 * \ldots * V_m$, V_i is a set of states ai in terms of generalized variables, as the chanels of observation.

Our experience of the work with UES shows that its possibilities in improvement of quality education of applied mathematicians is considerably determined by its controlability. Controlability of any program complex depends on many factors: the level of complexity; amicability of the dialogue interface with Users; degree of freedom in the use of its various components; reserve of reliability and stability. An important factor of controlability of any program complex including UES is the presence among its components of the System imitating environment and the system of results processing for UES functioning in the real time scale. Imitation of Users messages in UES is realized on the basis of imitation of standard data and calculation of random corruptions and errors basing on those data. The routine results processing is made on the basis of formation of the named users files accumulating the data characterizing the mode of simulator using and the degree of skill in design of mathematical models. To realize the named users files standard table of the typical methods and procedures of mathematical models design has been formed. It is just used by UES to manifest the methods and procedures the user has mastered and in the education process UES automatically formulates new concrete problems. The problems include indications at those sections of Information fund which must be acquainted and the practical problems which should be solved. UES has the procedure of discard of the named users files from the Library of the named files since the User has completely mastered all the procedures provided in the course of "Modelling of economic and manufacturing processes".

UES must have the procedures of account of failure situations. The failure intensity depends on the level of debugging of program units used by UES and intensity of distortion of the original information arriving from users. File of failures account allows the Teacher being one of the Users to define the rational and necessary ways of UES development.

THE SUPPORT ATS WITH THE ARTIFICIAL INTELLIGENCE ELEMENTS

I.L. BRATCHIKOV, I.V. SIMONOVA
Robotic Lab., Department of Applied Mathematics
University of St-Petersburg, St-Petersburg, Russia

Keywords: support automatized teaching system, programming learning, author's language, pupil language, artificial intelligence.

The automatized teaching systems (ATS) of new generation which are usually called expert teaching systems are under development both in this country and abroad and first of all directed at overcoming shortcomings of the existing systems, mainly based on the ideas and methods of programming learning.

The structure of the ATS being under development as a modular one is assumed as a basis of narrow kernel that can be increased by addition of modules. This allows to tune the system in the proper application domain.

The means put at support ATS author's disposal allow the following:

- Prescribing modes and structure of a training material.
- Editing and storing it in the special way.
- Describing the learning process by means of the proper script that enable one to take into account the results of learning.

The versions of representing the control and cognitive information on the screen of the terminal and the form of dialogue of the user (the author of the course) and the system are the parts of the interface means (IF) to be under special development.

The system enables the author to realize the script he'd like it to be linear, or branching or combined.

The narrow kernel includes the following means: the pupil language, the text and the graphic editors, the reference system, directives of teaching sessions updates and file system maintenance.

All the programming modules are independent of each other and influence each other only by means of the global values.

As a part of the narrow kernel the ATS is implemented in the following programming systems: Turbo Pascal, the system based on the FORT language, Turbo Prolog.

By the present the implementation of ATS in the Turbo Pascal 6.0 for the IBM compatible computers has been completed.

We have provided the addition of modules allowing to bring the AI (Artificial Intelligence) elements into the system for the test questions generation , pupil answers analyzing with the aid of the proper KB and inference mechanism and for the reference and consulting system. The last one is realized as a built-in expert system.

We have enlisted the co-operation of the Mathematical Faculty of Pedagogical University students in the teaching courses working out to approve the system.

This enables to correct up the author language structure taking into account the teachers needs and possibilities, the potential system users. In our opinion , the approach of this kind is necessary for providing the possibilities to introduce the system under the real conditions of the learning process realization in modern differentiation.

INTEGRATED AUTHORING SYSTEM FOR TUTORING ACTIVITY

A.V. BUDIKHIN, B.E. PICHKOV, O.N. YAKIMOVA
Moscow Car & Road Institute
64, Leningradsky pr., 125829, Moscow, Russia

Keywords : authoring system, database of teaching materials, intelligent tutoring system, prolog

Currently available educational systems for higher school suggest using complex integrated packages. These systems based on databases and knowledge bases are realized as Intelligent Tutoring Systems.

The most important functions of these systems are computer-aided authoring and tutoring activities.

This paper discusses the main principles and some characteristics of the integrated system for authoring and tutoring activities. The creation of these systems is an extremely complex process now. Our system is based on representation of teaching materials in the form of the structured database which contains information concerned with Application Domain.

One of the main features of our system is easing the process of creation and control of large arrays of information for different disciplines.

To reach this aim a certain structure of information, stored in database was developed. General relation scheme of database has a number of relation subschemes. The main relation "fragment - abstract image" has been set up among some fixed portions of teaching information (texts, tasks, questions and others). Different fragments of teaching materials are connected by means of dynamic pointers with problem area for teaching (subject, topic, chapter and document for teaching).

On the one hand, having formed this database, the tutor can use it in "everyday life". He can build any type of documents needed for preparing and using such tutoring activities as lectures, laboratory study, examination cards and others. On the other hand, this system allows any automatized courseware to be realized.

The system includes built-in text editor that can operate in separative windows. Because of that, the tutor can modify and expand all existing teaching materials from very simple to extremely complex level.

In addition, the user can display and fill out a special set of current standard documents. Furthermore, resulting information can be calculated and output documents can be formed. Using these features, the tutor can avoid much routine work.

Our system is realized in Clipper 5.01. Some additional parts are written in C. The system is developed for commercial use. All parts are compiled in the form of integrated system called "Prepodavatel" ("Tutor").

"Prepodavatel" is implemented on IBM XT/AT (and compatible with them) under MS DOS 3.30 or later. It requires 640 K memory and hard disk. Installation procedure is as easy as not to require special skills. The system is simple and reliable, context-oriented help is available anywhere.

At the moment, our system is being used extensively for creating computer based documents and different courseware realized in intelligent shell environment written in Turbo Prolog.

Further development of our system will be conducted along the following two directions. New integrated knowledge base is supposed to be used in the faculty's teaching specialization and to be put on file-server of local area network under Netware 3.11. This feature makes it possible for different authors to get access to shared database according to their status. Also, the next step is knowledge representation as graphic images. This will make it possible to combine the flexibility of data representation and some kind of graphic teaching materials. The above characteristics of the system are to be discussed in greater detail in the report.

INTELLIGENT SHELL FOR COMPUTER-ASSISTED LEARNING COURSES GENERATING

A. BUDÍKHIN & V. POGORNEV
Moscow Car & Road Institute,
64 Leningradsky Prospect, Moscow, 125829, Russia

Keywords: distributed system, intelligent tutoring systems, knowledge base, local area network, prolog, shell

Questions of the intelligent shell's design for computer-aided tutoring systems creating and supporting are discussed in this report. Actual problem nowadays for high education is organizing of such systems using proposed tools and methods of artificial intelligence for training courses building and students knowledges evaluation.

Describing system is based on basic Prolog possibilities and some original authors techniques such as:

- Learning course structuring to the set of topics and chapters and the set of tasks.
- Student model building during education.
- Fuzzy sets and functions concepts used for learning process control.
- Elements of hypertexts and natural language treating included.
- Grouping education process organized on Local Area Network.
- Separate authors, administrator, teacher and pupil subsystems.

Architecture of this system contains: 1) intelligent interface; 2) learning course realization subsystem; 3) learning process monitoring subsystem; 4) distributed knowledge bases which include data about: universe of studied subjects problems, used learning strategies and current learning process.

Learning process is controlled by rules and facts of this knowledge bases and have to support by the teacher.

Supporting student model is important for knowledge evaluation process (as a sequence of tasks and data chunks) and resulting teacher conclusions about it's validity. This problem is solved by maintenance of variables row such as maximum, average and last value, average solving time per task and rates of them, number of valid answers etc. Resuming student rate value is the function of this variables and aims to teacher resulting evaluation or control courses corrections.

Distributed intelligent shell was written on Turbo Prolog v.2.0. Some LAN interface supporting modules realized in C.

This system works on IBM PC XT/AT or compatible PCs and can use networks under Netware 3.11 LAN operating system.

MEANS AND TOOLS OF THE INTELLIGENT INTERFACE CREATION FOR THE TRAINING COURSES

TATIANA DOVGIALLO, ALLA MANAKO
Glushkov Institute for Cybernetics, Ukrainian Academy of Sciences
40, Prospect Akademika Glushkova, 252207 Kiev, Ukraine
E-mail:dovgkiv@sovam.com

Main purpose of the research is the creation of easily adapted universal software, which allows to automatize the construction of the training course, adapted to the any subject field. To solve this problem the research was carried out to apply the erratic logic to the questions generation. "Raw

data" is the information on the learning subject, which can be obtained from the hypertext and integrated into the training data base. These are the statements, produced for learning, the notion and action.

The convenient interface was created in order to work with learning extracts. Interface allows generate the questions to subject of learning and fill up simultaneously the electronic book, systematized in accordance with learning subjects and studies.

One of the basic problem of the project is definition of the semantics of questions, the notions of the true reply, and also the study of the conditions of the understanding of the questions by the addressees and the so called pragmatic aspect including expedience of generation as well as practical significance of the questions for different fields of knowledge.

System means provide the correlation among the subjects of the learning process, statements, associated actions on the one hand, and the generation of the questions and replies recognition on another hand. The statements, notions and interrogations are linked with the formulas of the questions, which aren't the subject of the present work.

The answer classifier is created present information of type, formula and contents of each question in the most convenient and description form. The classifier can be presented as the menus composition. Thus the hierarchy structure allows the mode of the questions generation.

The question-answering theory development and application make evidence of the new-type question as effect to the new data acquisition and accumulation, the basic non-trivial questions selecting as subject for answer.

The files of data are saved in the external memory, the access is provided in the operational zones of memory. The simultaneous access is limited to 10 bases.

The Data Bases System purpose is the data base support within the technology, the base for the data accumulation to make up the progressive tool to train the users of different ages and professions.

UTILIZATION OF HYPERMEDIA IN UNDERGRADUATE ENVIRONMENTAL EDUCATION

B.A. ENGEL[(*)] , D.D. JONES[(*)] , S.M. ALLEN[(*)] , M. BLAND[(**)] , A. KRAUSE[(**)]

(*) Department of Agricultural Engineering, Purdue University
1146 Agricultural Engineering Bldg.,
West Lafayette, Indiana 47907-1146 U.S.A.
E-mail: jonesd@ecn.purdue.edu
(**) U.S. EPA, Region 5, WCP-15J, 77 West Jackson Blvd.
Chicago, Illinois 60604-3590 U.S.A.

Keywords: hypertext, education, environment, autotutorial, CAI

In the spring semester, 1993, the authors utilized a series of hypertext computer programs in conjunction with a conventional lecture format to teach environmental issues and problem solving to junior- and senior-level agriculture students. The name of the 3-semester-hour class was Rural Environmental Engineering. The objective of this course was to provide an understanding of rural environmental issues and their engineering solutions. Students completed a term paper that dealt with rural environmental issues and engineering solutions to the problems. In addition, the students completed homework and a term design project related to one of the course topics. The course utilized computer-based educational modules and appropriate journal and popular press articles to support lectures.

Twenty-two programs, involving an average of over 30 hours of instruction, were utilized. These environmental programs were developed over the course of the previous four years by Purdue

University with funding from the U.S. Department of Agriculture and the U.S. Environmental Protection Agency.

The programs use either EGA, VGA or SVGA graphics with numerous color images to illustrate important principles. All programs were installed on a server in a networked student laboratory where they were available to students at any time. All programs were used on a walk-in basis at the students' convenience, rather than in a formal laboratory setting. The programs were assigned and utilized to supplement and clarify lecture/discussion items.

Topics included in this class were: environmental impact assessment in developed and developing countries; water quality and quantity issues; soil erosion; animal manure handling and application to farmland; water conservation; rural sanitation; and environmental risk assessment techniques.

Student evaluations were collected for the first semester that the autotutorial programs were used. These evaluations have been summarized and will be used as the basis for future course changes. At the demonstration several of the programs used in this class as well as a course outline will be presented.

The completed class outline follows.

Week 1: Course overview

Introduction to Course

Rural Environmental Issues

Environmental Impact Assessment

Environmental Impact Assessment (EIA) *

Week 2: Global environmental change

Environmental Data Sets

Local, state, national, and global data sets

Computer Technologies for Rural Environmental Engineering

GIS (Geographic Information Systems)

Simulation

Week 3: Rural water systems

Overview of hydrology as it affects rural US

Groundwater Education System *

Surface Water Education System *

Week 4: Rural water quality and quantity requirements

Farm Water Requirements (Fire, Animals, Home, Irrigation)

Water quality standards

Water Conservation *

Week 5: Water supply systems

Principles of hydraulics (plumbing layout and

design/anti-backsiphoning devices/water hammer,

head loss, elevation loss, etc)

Wells/Springs/Ponds/Cisterns

Community Water Supply Systems

Private Drinking Water Systems *

Week 6: Protection of surface and ground water quality

Point-source contamination

Non-point source contamination

Best management practices

Groundwater NPS Pollution Best Management Practices *

Erosion Best Management Practices *

Sustainable Agriculture *

Minimum tillage video (Purdue/OSU)

Week 7: Engineering practices for water quality protection

Irrigation and the Environment

Wellhead Protection *

Week 8: Farmstead environmental assessment principles

Well Location and Condition *

Soil and Geologic Conditions *

Week 9: Farmstead environmental assessment principles-continued

Design of fuel storage systems

Design of fertilizer and pesticide storage facilities

Fuel Storage *

Fertilizer Storage *

Pesticide Storage *

Week 10: Farmstead environmental assessment principles-continued

Household/Farmstead Hazardous Waste Management

Livestock Yards Management *

Livestock Waste Management *

Milking Center Wastewater Management *

Silo Seepage Management

Week 11: Animal manure treatment and utilization

Handling, storage, treatment and land application

Composting, anaerobic digestion, refeeding, lagoon, earthen pit leakage, fate of Nitrogen and Phosphorus in runoff and land applied manures

Gas, dust and odor control around animal production facilities

Field trip to Purdue Dairy Center to see solids and liquids separator/milking parlor

Week 12: Human Waste Disposal in Rural Areas

Septic Systems

Options for Unsewered Communities*

On-site Tutorial*

RWASTE*

Week 13: Rural waste disposal issues

Injection Wells *

Landfills

Land Disposal of municipal sludge/septage and industrial wastes

Dead animal disposal

Field trip to Purdue Poultry Center to visit dead bird composting

Week 14: Wetlands

The wetland ecosystem

Principles of wetland design and operation

Wetlands Education System *

Constructed wetlands including

Constructed wetlands for treatment of animal wastes

Field trip to constructed wetlands at Baker Farm

Week 15: Environmental Impact Assessment

Procedures for EIA

Environmental Impact Assessment (EIA) *

Week 16: Student term project presentations

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* - Computer-based multimedia modules

KNOWLEDGE-BASED LABORATORY

VLADIMIR V. KARTAVTSEV
Intercomputer GmbH, PO Box 62/4, Kiev 252195, Ukraine
E-mail: kart@infosys.courier.kiev.ua

Keywords: knowledge base, machine learning.

The paper deals with problems of applying artificial intelligence ideas for tutoring goals. One of them is active interactions between a student and studied material. The paper describes an architecture of knowledge based environment, which allows for students to investigate laws in studied domain. The architecture has been implemented in FISHING system by means of Expert System Building Tool ITS 2.0.

ENVIRONMENT

A studied domain may be considered as a set of objects (parameters, factors, etc) and a set of connections (relations, causalities, etc) among them, which a student does not know well.

The tutoring environment consists of the following parts: Handbook, Laboratory, Taskbook.

The Handbook includes structured knowledge and facts from domain. They may be represented as hypertext, pictures and animations. The Handbook's resources are available in any part of the environment.

The Laboratory is offered for student's experiments in domain. It includes one or more situations, which demonstrate what will be happen, when the student has changed some parameters. Main goal of the Laboratory is to help the student in understanding of laws and causalities between objects. On one side, he may ask an explanation for received results or read corresponded information in the Handbook, on other side, he may check your knowledge by Taskbook.

The Taskbook includes a number of tasks or problems, which a student must solve. The tasks are connected with the studied material and have different complexity levels. The tasks may be the following types:

- A student should make some decision (or answer on a question) on base of given facts.When all of these facts are concerned with the problem (question), or when a part of these facts are not concerned with it.
- Student should choose the concerned parameters himself and then make a decision on base of some values of the parameters.

The environment is supported by a knowledge base.

KNOWLEDGE BASE

The knowledge base for the environment consists of objects and connections among them and forms a studied domain model.

An object is described as some domain parameter or factor and consists of its name, a set of its own possible states (values), and a set of other objects, which may be useful for determination of the object's real (or current) state. For example, it may be (in some domain) rain object, which has "rain" name, "will be" and "will not be" values, and "temperature", "wind" and "cloudy" objects as useful ones for rain determination (prediction).

A connection is described as some domain relation or causality among some objects. For example, such relation take place among "rain" and "cloudy". In particular, if (it is not cloudy) then (it will not be raining).

It is very important to describe the studied domain with adequate connections between objects and knowledge acquisition from an expert about these connections is a bottleneck in this process. Machine Learning approach suggests to represent expert's experience as a set of case (or examples) and then to generalize them for all possible cases. Besides, each case may be connected with some expert's comment, which explains the situation and the connections between objects in it (why did expert make this solution and didn't others ?).

The knowledge base supports the Laboratory's functions as well as the Taskbook's. In particular, in the Laboratory the base:

- Provides the decision making to detect influences one part of objects on others, when student has changed a value of some parameter.
- Explains the influences.

In the Taskbook it

- Supports right decisions for each task.
- Explains student's failures.

IMPLEMENTATION

The elements of the architecture has been implemented in FISHING system, which has been produced by Intercomputer GmbH, Kiev. This system is offered as consultation supporting for users about some problems connected with fishing, such as a choosing of place for fishing, a fish nibbling prediction, a choosing of fish's bait and others. The knowledge base for the system has been developed by means of Expert System Building Tool ITS 2.0.

PALEVAS/I : TECHNOLOGY OF CREATION ADAPTIVE TRAINING SYSTEM

VALENTYNA V. KOLOS, SVETLANA P. KUDRJAVTSEVA
Glushkov Institute for Cybernetics, Ukrainian Academy of Sciences
40, Prospect Akademika Glushkova, 252207 Kiev, Ukraine
E-mail:dovgkiv@sovam.com

1. Introduction

At Glushkov Institute for Cybernetics the technological line for creation educational instrumental and applied software is elaborated. Applied software, that take into consideration individual peculiarities of the student i.e. adaptive training systems (ATS) - take the special place among educational instrumental and applied software.

Adaptive training system is the training system that evaluates and corrects characteristics of student model in real time, changes teaching method or chooses next instructional influence on the basis of student model to achieve optimal meaning of the characteristics of teaching quality.

2. Requirements to ATS

We will demand the following requirements for an ATS:

- Teaching system would ensure storing and processing of the information about moving of teaching process and the results of execution the control and educational tasks by student and so about number and types mistakes that student made.
- Representation of educational information using in ATS have to be convenient for realization of flexible teaching methods that take into consideration the state of the student model for decision the task of control the teaching process. This representation have to allow to change intensity of teaching process, sequence and content of educational information to optimize teaching quality.
- Teaching method, realized by ATS, must based on teaching quality criterions (specialed for each ATS) connected with means of the student's characteristics, the results of study the educational material by student and peculiarities of teaching process (for example, consequence of study the concepts of problem domain). Besides of that the method have to execute choice next teaching influence to improve the teaching quality by achievement of teaching goals. This method is named adaptive teaching method (ATM).
- Interface of ATS must inform the manager modules about moving of teaching process on the whole. These modules execute collection and processing of the student's messages. Student's messages contain answers on the educational tasks, information about necessity of giving the student help explanation, etc.

Requirements to ATS are an influence on the characteristics of the informational filling the ATS. Informational filling must:

- Correspond to tasks solving in the teaching domain.
- Make sure visuality and structurity of the educational information that promote realization of individual teaching.
- Adequately reflect peculiarities of the student and the results of teaching.
- Visually and constructively describe ATM.

These requirements are took as a principle of the Educational Knowledge Structure (EKS), what are basis of ATS knowledge base. EKS - educational and methodical knowledge represented by convenient manner for realization in ATS [1]. EKS are problem domain model (it includes next structures: topic, lesson, task), student model, teaching method.

3. Requirements to technology of creation ATS.

Technology of creation ATS must:

- Make sure realization of several teaching methods.
- Give possibility for dynamical construction of sequence exposition of the educational material.
- Create the conditions for control of degree mastering of the educational information in the teaching process.
- Make sure forming of graphic support for curriculum.
- Have tools for description of adaptive teaching method.
- Have unified algorithm for execute of adaptive curriculum.
- Give for designer the form of special knowledge structures that can be used by unified algorithm and rules of building these structures. These structures must reflect educational information, requirement to teaching method.

4. Short description of the technology PALEVAS/I.

Technology PALEVAS/I works with 3 types creators of curriculum:

- Teacher (he/she is a specialist in the problem domain);
- Knowledge engineer (he/she projects and realizes ATS);
- Designer (he/she realizes graphic support of teaching process).

All specialists interact with each other by means of EKS. The process of creation ATS is divided into three stages:

- First, the specialist at problem domain prepares educational material and formulates requirements to teaching method (he/she works with text files only).
- Second, the specialist in computer graphic creates graphic representation of educational information.
- Third, the knowledge engineer makes project of the system, oriented on individual teaching of the students. He also executes realization of system modules. This specialist works with knowledge models, describing process of creation ATS. The technology gives convenient tools for each specialists.

Some ATS were realized in the technology PALEVAS/I.

For example:

PALEVAS - training system for logical programming (formalization of subject domain);

ADT - curriculum for automatical theorem proving;

PUMP - curriculum for search of disrepair of the mine water tide system;

Train of signal service operate.

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SOFTWARE TOOLS OF WORKING OUT INTELLIGENT INFORMATIONAL-TEACHING SYSTEMS

VLADIMIR L. KUDRIAVTSEV(*), ALEXANDER A. BOIKOV(**)
(*) Moscow Institute of Instrument Making, dep. PC-5,
20,Stavomitnaya St., box:107076, Moscow, Russia
E-mail:vep@Oktava.msk.SU
(**) Institute of Technical Teaching Systems
3-rd Kabelnaya St., box:111024, Moscow, Russia.

Keywords: hypertext, intelligent interface, task machine, software tools, intelligent teaching systems

Informational Teaching System based on a hypertext integrates into itself possibilities of informational teaching systems. The central problem of these systems is the problem of interaction of the system and its user. The essence of the above mentioned problem is that there is not full and/or inexact understanding of the tasks by both the user and the system, the tasks which are raised and to be solved by each side. There are different ways of solving the above mentioned problems and one of the most long-range is intellectualisation of the systems.

Intellectualisation of the system is a means to increase the effectiveness of its usage (intellectuality of the system should be recognized here as its possibility to solve the problems with the algorithm unknown beforehand).

In this article we consider methods of approach and means of realization of the following directions of intellectualisation -IITS: intelligent interface, and intelligent task machine (processor).

The task of elaboration of the intelligent interface with a system is an independent and difficult problem. The most radical way of its solving is, undoubtedly, to work out an interface using natural language. At the same time it should be noted that an interface based on the natural language can't utterly solve cognitive problems, in particular the problems of " mutual understanding of tasks".In this work intellectual interface is used like the means to raise the problem and to shorten the cognitive distance between the model of the user's task and the model of the task of the system. Here we also consider different means of direct manipulation by elements of the task and methods of their screen presentation.

The architecture of IITS supposes availability of intellectual interface, containing user's model and describing his aims and motives ("point of view") and the model of knowledge, the means of the direct manipulation by the objects, means of screen presentation and the problem machine. The last one realizes both solving of local tasks (for example the search of inquired information) and global ones (teaching in accordance with the accepted strategy, the level difficulty of the material and others). Both the model of a teacher and the user (pupil) can play the role of a global task raiser.

The task machine is realized on the basis of general theory of solution of problems of the kind

$V^*, P; W$

where V^* - means the point of departure of the system, comprehended as a subset of the V-set of various elements and connections of the system,

P - means the set of various operators of the system, realizing mapping of V- V, that is transferring the system from one state into another,

W - is the aim (the final multitude of acceptable positions.

On creation of applied IITS the same problems like on their usage appear, so the same principles and methods can be used on elaboration of software tools.

The instrumental means of elaboration of IITS include a programme-designer and a number of utilities.

Functional abilities of the designer:

- Creation of the knowledge base as a hypermedia (hypertext, drawings, sound fragments).
- Manipulation by a text (creation and editing of texts, hypertextual foot-notes and links of different kinds among the elements of one and several text files, color making of text fragments and keywords).
- Manipulating by graphical files directly out of the designer programme against a background of the edited text, transference of an image along the display within the memorizing its co-ordinates.
- Simultaneous editting of a text and manipulation by the the image (adjustment of the text to the disposition and the size of the images).
- Listening through the files of the sound library, creation of connections like textual fragment - sound fragment, drawing - sound fragment.
- Creation of the so called stereotypes which are at the same time basic elements, used by the processor to build up algorithms for solving different tasks appearing during the work of system.

On the basis of the above mentioned methods prototypes of software tools and IITS (on basis of one of electrotechnical course) are created.

COMPUTER-AIDED INSTRUCTION AND TEST OF KNOWLEDGE

ALEXANDER S. MENAYLENKO
Computer Science and Computing Machinery Department
Lugansk Pedagogical Institute
4, Stalingrad Heroes Block, apt.70,
Lugansk, 340006, UKRAINE

Keywords: instruction, exercise, set, the students level, operator instructing information.

Last years in modern pedagogics and psychology more attention was paid to individualization of training and particularly to methods of using the idea of computer-aided instruction.

Mentioned above methods of instruction however didn't find allround and wide application in practice, because of a number of unsolved problems preventing the realization of these methods with the help of computers: formalized algorithms of students' classification according to their level are not worked out yet; a number of levels is not determined; instruction control strategy choice algorithms are not worked up, etc.

To solve these problems it is expediental to make use of some theoretical and experimental methods applied in cybernetics, psychology and pedagogic.

The structure of the instruction process can be represented by four main constituents: a teacher, a student, a subject and a computer which interconnected by direct and reverse probable links. It is being known that a teacher and a student can be subjected the influence of interference (or noise) $e(t)$ and $h(t)$.

Definition 1. A set of student psychological parameters j determining it capabilities for instruction will be called as student (j) primary characteristics $X_j(x_1,\ldots,x_i,\ldots,x_n)$.

Definition 2. Set m is some set of students j with primary characteristics $X_j(x_1,\ldots,x_n)$, $1 \leq j \leq n$, it includes m students subsets, called K levels, it is being know that $K=\{1,2,\ldots,m\}$.

Definition 3. Subset of students primary characteristics $X_j(x_1,\ldots,x_n)$, defining students implement to K level, is called as student image $O_j(x_1,\ldots,x_l)$, $l \leq n$

Definition of an Instruction Control Problem.

Set the instruction system has for m statistically different K levels of students the corresponding sequence semantically substantial portions of instructing $U_1[n]$ and testing $U_2[n]$ information. A student is represented as a pair

$$A = <F,Z> \quad (1)$$

where F is an operator, characterizing student individual capabilities for instruction; Z is an operator characterizing students abilities to answer the given question.

Set $F: O_j(x_1,...,x_l) \Rightarrow K$ defines the student individual capability for a definite subject. The view of operator $Z: X_j(x_1,...,x_n) \Rightarrow Z^*$ is unknown, but it is certain that

$$Z^* \Rightarrow max \quad (2)$$

with a certain K level of student and

$$U = U(K) \quad (3)$$

where U is an instructing information (control influence); $U(K)$ is a sequence of instructing information portions $U_1(n)$ for K level.

The problem of instruction control is in the fact that for K arbitrary level of students capabilities it is necessary to find such sequence of instructing and testing information $U(U_1[n],U_2[n])$, in order that $Z^* \Rightarrow max$

The problem is solved in two steps:

1) a number of levels $m = 3$ is defined. It was determined by reconstruction of distribution density of students primary characteristics probability, which forms it image. It is determined that the resulting density of the distribution probability is a mixture of student images distribution;

2) on the base of maximum posterior information criterion $I(Q)$ were developed algorithms to make a choice of instruction and test strategy $U(U_1[n],U_2[n])$, with a use of Q probable reverse link in a student-computer chain.

Algorithms investigation was carried out with computer numerical modeling as well as experimentally with the help of secondary school students. As a result of investigation it was determined that the identification of K level and choice of instruction and test strategy is carried out unambiguously and the probability of estimation of the correspondent level $P_k(H_k/Q)$ approximate 1, and a number of questions n for $U_2[n]$ when $P_k(H_k/Q) \geq 0.85$ and $m = 3$ is equal 10-12, that is quite permissible in computer-aided instruction.

The developed strategies choice algorithms are represented in "Рідна мова" ("Native Language") software package as well as in instruction and test programs in computer science and mathematics.

THE TOOLS OF CHILDREN INTELLECT DIAGNOSIS.

OLGA L. PEREVOZCHIKOVA
Glushkov Institute for Cybernetics
Ukrainian Academy of Sciences
40, prospekt Akademika Glushkova, Kiev 252207, Ukraine
E-mail: gorxmaz@d145.icyb.kiev.ua

The LOGOEX system is aimed to medical examination of a child with detaining mental intelligence and is called to substitute for routine work of psychologists, defectologists and logopeds on testing big patient groups.

The following functions are provided:

- Using graphic computer tools to create natural environment of child testing.
- Statistical treatment of test results and keeping patient database containing examination histories and test results in graphic form for convenient documenting.
- Explanation of reasoning and marks received.
- Teaching the system with correspondent database modification and creating pictures and cartoons which accompany new texts by their verbal description.
- Formulating new system aims with correspondent content of knowledge base.

LOGOEX includes 25 practical tests on research of the phonematic perception and the knowledge though, lexicogrammatical structure of speech and simultanical gnozise, that are substance of medical defectology. For the present, the methodic of Hertsen Pedagogic University (St.Petersburg) are applied in LOGOEX, the realization of methodic developed in the Institute of Psychology (Kiev) and the Center of Social Investigations (Chelyabinsk) has begun.

To serve users having different education levels LOGOEX contains teaching and informating functions which make testing easier.Teaching materials are grouped in correspondence to functional content of tests in medical defectology: each group of tests includes original methodic of patient examination. During the testing an experimentator can study diagnostic methodic and obtain system help in active regime.

ADAPTIVE HYPERTEXT TUTORING SYSTEM ISIS-TUTOR

LEONID A. PESIN
Applied Mathematics and Cybernetics Department
Moscow State University
90, Leninskiy Prospect, Apt. #48, Moscow 117313, Russia

Keywords: tutoring system, adaptive task sequencing, hypertext, response-sensitivity, print format language, concept net, student model, teaching operations

ISIS-Tutor system described in this paper represents an adaptive hypertext tutoring system intended for studying print format language of package CDS/ISIS/M. ISIS-Tutor is written in ISIS-Pascal for IBM PC with using CDS/ISIS/M possibilities.

The remarkable peculiarity of ISIS-Tutor is response-sensitivity, that is an ability of the system to adapt its actions for any particular student. It reached by using interactive mode, when student demonstrating his skills and knowledge or specifying his wishes can influent on sequence and character of teaching operations. Response-sensitivity of the tutoring system is necessary for intensive and qualitative learning process. In accordance to Heines and O'Shea [1], one teaching system is more response-sensitive than another if in some sense it is more adaptive to individual learning needs of the student being taught than the another system. In adaptive system an

instruction sequence depends from student's possibilities and teacher's wishes. In standart approach student gets a rather fixed sequence of tasks and texts with new material. Adaptive task sequencing means that knowledge demonstrated by the student formerly are analyzed and system selects an optimal teaching operation. The student knowledge is represented in the Student Model reflecting the level the student has mastered each domain concept (skill). Every task is connected with a set of concepts (skills), which are required for its solving. Thus by using the Student Model and task description system can select an optimal task for the given student in each stage of learning.

These ideas are used in ISIS-Tutor system designed in ICSTI and Moscow State University. The system controls the study of print formatting language for CDS/ISIS/M package. This package is menu-oriented information-retrival system. Print formatting language is a key to many CDS/ISIS/M operations and to master this language is important for effective use of the package. In ISIS-Tutor knowledge about language is divided by elementary concepts. The material being taught is represented as a directed graph (concept net) that defines prerequisite relationships between concepts. The overlay Student Model reflects the extent the student has mastered language concepts.

Since the material elements are connected to each other in the concept net, it is convenient to use this structure as a base of hypertext. But apart from prerequisite relationships the system can also operate with similarity of concepts, its membership in one common group and so on. Thus, studying any concept user can select from suggested list connected concept and go for it. In the same way student can go to another concepts connected with new one and so navigate in the concept net.

There three kinds of teaching operations in ISIS-Tutor: concept presentation, task solution and example analyses. The last operation can be requested from concept presentation window, where concept description, list of concepts connected with the current one and list of examples are offered to user. If he selects one of these examples, system sequentially executes each command of print format example and displays results in special window on screen. This practice can help to possess the concept deeper. Tasks used in the second kind of teaching operation - task solution consist of two basic groups: tasks for analyses and tasks for design of print formats.

Each step of learning process in ISIS-Tutor is selection and solving of a task or selection and studying of a new concept. The choice can be done by the user or by the system. In the first case user selects next teaching operation himself from suggested set of relevant concepts to study or task to solve. The mode can be usefull for rexperienced student perfecting himself in the language and for teacher, who wants to set a learning order for his student. In the second case system by using the Student Model selects optimal teaching operation. Just this mode gives the adaptive sequence of tasks and concepts. System tries to offer a task for mastering concept which are known but not consolidated by solving enough of tasks. If there is no such a task new concept for study is selected. To repeat presentation of concept or task solution is also possible. This possibility is usefull for a weak student, who has not mastered the material very well. In any case selected teaching operation consists of a concept presentation or task solution. Its results are reflected in the Student Model.

Thus studying print format commands over the hypertext, analysing example formats and solving tasks student gradually masters the art of CDS/ISIS/M print format language using.

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COMPUTER-AIDED TEACHING SYSTEM FOR BLIND USERS

IRENE PHONCOVSCAYA, YULIA SHVARTS , TIGRAN TERZIAN
Glushkov Institute for Cybernetics
Ukrainian Academy of Sciences
40, prospekt Akademika Glushkova, Kiev 252207, Ukraine
E-mail: gorxmaz@d145.icyb.kiev.ua

The teaching of informatics in schools for blind children is very difficult, because it need in additional expensive technical facilities and in implementation of new methodics oriented to blind users.

Authors made attempt to create cheap interface tools and measuring-teaching complex which necessary for evaluation options of interaction between blind-users and computer and appropriate for native tools widespreaded in schools.

An interface bases at speech synthesizer with exit on head phones through simple analog-to-digital converter. Last is attached to parallel interface chanal. Data are entered with help of standart keyboard, formatted specific for the tactile orientation in key layout.

System allow to blind user to receive practical knowledges in work with computer keyboard. It studies to work with different types of menu, first-hand acquaintance with logic and programming languages bases elements and measure pupil reactive characteristics and operative customize interface options. By this means the facilities which has been created not far from electronic learning system [1], and them are supposed building of: model of pupil, model of learning and model of subject environment. The model Carbonel [2] was selected as model of pupil. Basic knowledge about pupil is static in time psychological characteristic(uneasy and explained).

Learning system consist of: sounding keyboard trainer with speech commentary of key position, text editor with support of OS functions, sounding synthesizer of programs, set of games and facilities of administrate of measuring. Studying and measuring bases at plying process simulation. During it operative memory capacity, ability to apprehension system message on hearing, comfort organization of vertical and gorizont menu, ability to typesetting and edit texts are estimate. Time of reaction at message, correlation of correct and error operations, tiredness are measuring. During this process speech rate size and complication of phrases, exist of warning diagnostics, window size and nesting level, commands situation in menu and function keys assignment can be changed.

"Travelling" is the base of scenario of learning and testing. Pupil is the main active person in this game. He receive information about situation and necessary for success actions are proposed to him. The pupil is not informed about lesson (test) goal, it is just interesting to him gain: be first in equipment gathering, go out from labirint, deceive dragon...

Management system of testing decorate as interactive shell and realized next function: testing process installation, gathering of information, and testing results processing.

Gathering information about pupils is accumulated in archives file. It is processed after the lesson. During approve of complex was received next results:

- The optimal length of message is four words.
- The phrases are perceived better then separate words.
- The apprehension is better when the word is longer.

The results, which has been received, are uses in implementation of user friendly interface between blind users and computer.

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NEW INFORMATION TECHNOLOGY OF ARRANGEMENT OF TEACHING PROGRAMS

A.V. PROKAZNIKOV, T.O. VASILCHIKOVA
Microelectronics Institute, Russian Academy of Sciences
21, Universitetskaya str, Yaroslavl, 150007, Russia

Keywords: information technology, information units, indexing of information units, matrix of notions-connections, frame arrangement, program arrangement.

The usage of computer practically in all fields of modern society's activity causes high interest in the sphere of information technologies. They mean under information technologies the methods of processing and transferring of information with aim of its application to the concrete fields of human activity. Information technologies include processing, coding, transferring and presenting of information in the accordance with the certain laws. In the present time for these tasks the more fundamental theories of mathematics, physics, philosophy, psychology etc. are attracted. This work refers to creating of new information technologies and their computer realization in the field of education within the system "human - computer". The elaborations concern three general aspects, the work on that is carried out in parallel: 1) elaboration of general theoretical concepts of information systems with tutoring; 2) realization of computer teaching systems on the base of suggested theoretical concepts and elaborated technologies of creating of software for computer teaching; 3) approbation and investigation of properties of new information systems.

Concept being elaborated of information systems building is directed to creation of theoretical models, that are able to recognize the pattern and to teach themselves, and to investigations of methods of its realization in problems of computer teaching, so to the development, on the base of investigations carried out, the information technologies of creation of intellectual adaptive computer teaching systems. The theoretical concept is based on the two different approaches: the approach, which is based on the indexing of information units (IU), of that a program consists , and approach, which uses the analogy between visual image and a special presentation of a subject region being studied as a matrix of notions - connections . The first of these approaches is based on the theory of documents indexing and in mathematical aspects - on the SVD (Singular Value Decomposition) , the second approach is based on the methods of description of physical systems with spin (spin glasses, anti- and ferromagnetic and so on) as well as on neuron systems. This latter approach is based on mathematical apparat of pattern recognition theory. The information technology being elaborated would make it possible to rearrange the information units, that form a TP, under the guidance of a user as well as in autonomous regime under the guidance of a special program modules.

Let us consider briefly the first approach. The base of teaching programs (TPs) is a screen frame. The frame is an information unit (IU) of any TP. In order to use TP in education, the authors as a rule, by any way,put together with the help of software from finished frames the teaching program which is the sequence of frames. A number of put together such a way teaching programs are formed a package of TPs. Proposed information technology deals with more smaller IUs than a frame is. Such IUs may be graphs, formulae, comments, parts of a text, which form a frame. Information, which is kept in such a IU, may be described by means of a number of key words. IU may be schematically represented as follows: $M(a... b...)$, where M is an information in IU, a = 1,2,3 ... is an index which corresponds to a graphical representation of information, b = 1,2,3 ... is an index, which corresponds to an analytical representation of information etc.

An upper index (*a*,...) describes a type of represented information, a low index (*i,j*...) describes an array of corresponding key words. A very important moment of suggested methodology is determining of a distance between IUs,which may be determined by means of the scheme which is elaborated elsewhere. IUs,that are more close to each other in semantic space, may be put together in one frame with the help of a special elaborated software. More remote IUs form next frames.

The key point of a second method is a matrix of notions - connections.Its sense consists in a fact, that all the notions and all the connections between them, which are included into elaborated scenario of TP, are arranged by a special manner so that the whole picture is obtained, which looks like a table. This table is a matrix of zeros and units *A(i,j)* (0 - if the connections between notions are absent, 1 - if the connection is presented). The vectors in such an information space may be some parts of this large matrix (matrix of notions - connections): *(m,i,j)*, so that *A(i,j)* is equal to the sum over index *m* of *(m,i,j)*. We suppose to build a process of teaching on the base of introduced such a way information space.

The experiments on the work within frameworks of such a kind information space can help to reconstruct a concrete structure of this space. The first steps in this direction we offer to make basing on the analogy between matrix of notions - connections (matrix *A*) and visual image, which corresponds to the matrix *A(i,j)* (and also to the vectors *(m,i,j)* in this information space that form matrix *A(i,j)*). Both above-mentioned theoretical concepts are realized on the base of common for them software as well as on the base of earlier elaborated by authors concept of teaching by means of four - parts teaching program modules . Elaboration of software, in its turn, is based on the earlier suggested technology of creation of software of interactive computer based teaching, the efficiency of which was proved with the help of correspondence of programs, that were created on its base, to a system of didactic requirements as well as to conditions of information completeness and closure of a system "human-computer". The basic elements of elaborated technology looks like following: presentation of a subject region of a material being studied in TP as matrix of notions-connections, four-parts structure of teaching program modulus as a kind of more effectively transferring of knowledge to a student, and also a complex of tools program means, that realize suggested methods of presenting and transferring of information. The obtained results can be used by creation of teaching programs including the arrangements of screen frames, animation of pictures and usage of Multi - Media means as well as by usage of computer teaching programs in education. The theoretical part would make it possible to realize the regularities of construction of intellectual software, which would be done on the base of principles of indexing and of patterns recognition theory.

THE DEVELOPMENT TECHNOLOGY OF KNOWLEDGES-BASED TUTORIAL SYSTEMS

NIKOLAI G. SOZOROV (*) , DINAR M. BOGDANOV (*) & ILJA A. HODASHINSKY (**)

(*) Tomsk Polytechnic University

84, Sovetskaya str., Tomsk 634004, Russia

(**) Tomsk Institute of automized control systems and radioelectronics

40, Lenin av., Tomsk 634050, Russia

E-mail: ROOT@CC-TPU.TOMSK.SU or ROOT@TPU-VM1.TOMSK.SU

1. Knowledges Presentation. The information in the given tutorial system has been structured in such a way that it represents the standard training situation. The frame is used as the structure suggested. By force that the training may be represented as the process of training from one situation to another (or from event to event) the frames network simulates the process mentioned. Here, the frame-prototype consists of basic slot and some additional ones and process the following structure:

(Frame name

(Basic slot:

Base object frame: Pointer to recording in the the base)

(Reference:

group object : Pointer to the group name in the base)

(Help

group object : Pointer to the group name in the base)

(Model

element object program : Pointer to the external application)

.....

(Transition

element object relationship: Pointer to the relationship frame-frame)

Below the description of one of the slots is given as an example:

Slot: Reference

(Background - Reference:

Element object, Bit map: Pointer to bit map)

(Background - graphic pallet:

Element object, graphic pallet: Pointer to graphic pallet

256)

(Text - Reference:

group object: Pointer to the group name)

(Common menu:

element object Relationship: Pointer to the relationship

frame-frame)

slot example from the above frame:

Slot: Text - Reference

(Elita: Element object Font: Pointer to the font)

(Line : Element object Line: Pointer to the line)

(Line : Element object Line: Pointer to the line)

.....

(Line : Element object Line: Pointer to the line)

The hierarchy of the base, group and elementary objects will be cited in the report. The frame system is organized as the network of frames-instances in which only basic slot is required, the rest being defined by an instructor when necessary.

2. Knowledges Acquisition. One distinguishes two phases in the procedure of knowledges acquisition: preliminary phase and correction phase. At the first phase stage when the tutorial system doesn't exist, the instructor in collaboration with the engineer on the knowledges form the general representation about the frame structure and the structure of frames network. While considering only basic frame slots an involved. At this stage the instructor is able to appreciate the

period of training for different types of trainees. The interaction between instructor, engineer on knowledges and operator may be carried out by means of purposeful programmable tools, reflects the course model as an hierarchical structure consisting of different levels icons. An icon represents itself a real object in the course. It may be opened and one can see a real object. In every icon one can reserve the notes which are registered in the amendments list.

At the very first stage the instructor is able: 1) to look through the list of amendments occurred in the course; 2) to look through amendments and reserve one's own notes; 3) to edit the structure - add/remove the icon. The following is available for the operator: 1) to look through the list of notes; 2) to edit the course according to the notes; 3) to reserve one's proposals and questions.

The correction phase is characterized by that the knowledges changes and additions occur here. It is carried out with the help of psychological-pedagogical monitor [1].

3. Control. The system control is based on the training strategies set by an instructor and on processing the events and messages. The training strategies are set as the transition network between frames. The events and messages processing is based on the ideas of event-controllable programming. Responses analyzer is designed with utilizing the identifying devices to the mass of correct answers is based on the building up the reflexive-transitive linking on the automation configurations. An instructor describes the response in the terms of generating grammars the production of which is transmitted then into the automation instructions. The latters in their turn are transformed into the PROLOG closes with the subsequent building up reflexive-transitive linking.

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CHOICE OF INTEGRAL INDICES OF AUTOMATIZED EDUCATIONAL COURSE EFFICIENCY BASED ON CORRELATED STREAM GRAPHS.

VLADIMIR A. TALALAEV
Poltava, Ukraine

Most practical cases on estimating the efficiency of Automatized Educational Course is based on employment of multi-criterial estimate procedures.

However it doesn't witness "improvidence" of the approach, but proves the availability of a number of objective reasons. The main reason is the absence of well-grounded procedures of integrating par- ticular property indices of automatized educational course into summarizedindices of their efficiency. The proposed model is not a per- fect means of solving the problem and it only provides an essential drop of its extent. The basis of the proposed model is a modified method of D.Hais reason diagrams applied to the analyses of the hierarchical system of AEC efficiency indices. The application of the model as a compo- nent of the methods on estimating the efficiency of tool-making means for creating AEC permitted (to decrease) to reduce the extent of the mission on estimating AEC efficiency up to three. In the described case in order there was used a three-level system of hierarchically subordinated indices to estimate AEC efficiency. At the upper level we analyzed three integral indices of AEC efficiency, at the lower level - a total combination of AEC particular property indices. The ties between the indices of different levels at the stage of formulating an initial hypothesis have been determined by applying expert procedures with specifying these ties by means of the methods of correlating analyses. Then the operator equations have been made up. These equations help to determine analytical dependencies of the upper level indices with the indices of AEC particular indices.

INTEGRATED TOOL FOR TUTORING SYSTEMS. DESIGNING BASED ON INFORMATION TECHNOLOGY

T.O. VASILCHIKOVA , A.V. PROKAZNIKOV
Microelectronics Institute, Russian Academy of Sciences
21, Universitetskaya str, Yaroslavl, 150007, Russia

Keywords: integrated tool, tutoring system, information technology, information arranging, automatic arranging a screen fragment.

The problem of automation of teaching software creation process, i.e. the elaboration of tools which permit to realize some functions of education without using any algorithmic means of programming, becomes more and more actual in the sphere of computer based learning. In the present work the integrated tool intended for creation and exploitation of teaching programs is suggested. The program complex includes the realization of functions of presenting textual and graph information, modeling of studied phenomenon, control of comprehension and evaluation. The approach of designing such a complex, which uses the methods of information technology for arranging and structuring of information in a system, is described. The complex is being elaborated for IBM PC - computers in MS-Windows.

The complex consists of three basic parts. First, it is working part, which intended for the exploitation of a concrete teaching program. It is a finished structure of a teaching program, filled with a concrete teaching material and formed in that way a teaching program on the required theme, which can work independently from the complex.

The functioning of working part in its turn is divided by four parts: theoretical, modeling, controlling and evaluating. A frame of theoretical part includes graph window, window for a model, window for parameters of a model, window of text information. The task of this stage of work of formed teaching program is to present the learning material for a student.

The modeling part is a training one, which is based on the usage of animation and dynamics subroutines. While working with it the student can experiment with a model of phenomenon being studied by changing parameters of a model.

The structure of working part can be realized according to linear or branching functional schemes. The working of controlling and evaluating parts depends on it and includes a question, accompanying it a graph and several variants of answer as well as the system of consultations in theoretical and modeling parts and following it forming a mark of the quality of student's knowledge, taking into account the statistics of his work.

Second, it is service part, which is intended for creation of a sequence of frames of a teaching program. I.e. it permits for user of different qualification to input, without using a programming means, the material filling the theoretical, modeling or control fragments of working part of a program - textual comments, the parameters of a graph or model.

Third, it is a program editor, which is used to create and edit as the configuration of a frame of working part (a number of windows, their types and placement), so the configuration of working part as a whole (a number of fragments, their types, their succession and so on).

When working with this part and setting the structure of formed program user can fulfill, for example, the following actions: to set a number of fragments of a teaching program; to delete one part of a program; to delete a model or graph from a frame of working part or to change them by a picture; to change sizes and placement of windows in a frame. The access to the common file all of names of files, which forms a given teaching program, is also realized here. Among these files user can choose ones required for him: the subroutines of animation, dynamics, etc., set the files created by himself, for example, graphic pictures or shapes for a model.

A block of automatic arranging of a teaching program fragment from information units of different types - text, graph, model, etc. - also consists in the program editor. The arranging process is compiling, without usage of service part, the arbitrary combinations of information units belonging to the different screen fragments.

It is supposed to use two kinds of arranging or subsequent rearranging of screen frame: by user at his discretion in interactive regime while working with program editor and automatically by the arranging block of program editor. For the purposes of the correct arranging of screen frame by programming means the approach using the methods of modern information technology is suggested by authors. This approach permits to define a distance between information units on the base of indexing the information i.e. makes it possible to determine the information units of different types and from different fragments, which are the most close by their meaning. It gives the opportunity not to lose the meaning of both screen frame or fragment contents while automatic arranging. The block of information arranging can work also as a separate service program used for the rearranging of information in finished teaching program or in several programs simultaneously. Another function of the program editor is to join with multimedia systems. It includes in first turn the data preparing in necessary format and data exchange, the rearranging of screen frame, taking into account the video and audio information, as well as their processing.

Suggested integrated tool for tutoring systems permits to elaborate the teaching programs on different themes without using algorithmic means of programming. The four-parts structure of its working part gives an opportunity to cover the majority of pedagogical functions. The application of information technology approaches for the automatic arranging of information in the screen frame leads the realized program to high level of adaptation. And the usage of the system as a whole for the designing of tutoring programs permits to essentially optimize the process of their elaboration and can be useful also for the working in multimedia systems.

NATURAL LANGUAGE COMMUNICATION WITH RELATION DATA BASES

NATALY VLASSENKO
Glushkov Institute for Cybernetics
Ukrainian Academy of Sciences
40, Prospect Akademika Glushkova, 252207, Kiev, Ukraine
E-mail:dovgkiv@sovam.com

The problem of natural language (NL) communication and NL understanding is unsettled now to the full, but there are some narrow domains, in which the limited solution of this problem is possible. One of such domains is the NL communication with data bases (in particular - with relation data bases). Such systems are named NL information retrieval system (shortly in further - information system). The communication in this domain has some specific features. The main features are as follows:

1. Text of dialog in information system can be only prognosticated - it is generated in process of communication. The designer of information system deals with hypothetical inquiries of casual users.

2. There are only separate sentences (inquiries) on input of information system. This fact simplifies the process of inquiry linguistic analysis, because we have no needs to analyze the connections between sentences.

3. User's inquiries to information system are structured. The simplified model of inquiry (in each natural language) is:

<imquiry>::=<IP.><SP> , where

IP - informative part of inquiry (attributes of data bases or their synonyms), which is used for expression user's information needs;

SP - situational part of inquiry (values of attributes or their synonyms for searching the corresponding information).

These parts may be changed places, and may be subdivided.

When inquiry contains only one of these parts the inquiry is incomplete. In this case system asks to complete the inquiry. If inquiry have no words belonging to IP or SP, it is wrong inquiry.

4. A short form of answer can be used in information system . Ordinary, this is a name of data base attribute, that is contained in IP of inqqquiry, and value of this attribute.

We illustrate each of these features by showing how it could be presented in information systems.

1. Information system must have some means to help user correctly (from system's point of view) formulate his inquiry (what to ask about and how to ask). As such means we suggest to use "intelligent menu", which contains information about system's possibilities, about problem domain structure (number, types and names of attributes). Also information system have to show (on user's request) a list of words from dictionary, which can be used in NL inquiry.

2. The main system's purpose is to solve information tasks (non-linguistic tasks) therefore we suggest to use linguistic processor with goal oriented analysis instead of linguistic processor of natural language understanding.

3. Taking into account, that each inquiry has IP and SP we have to indicate explicitly in dictionary - belong the word to IP or SP. This fact on the one hand simplifies the inquiry analysis with subdivided IP and SP, and on the other hand makes the algorithms of analysis language-independent.

4. It is enough to use short answer instead of extended response.

Taking into account these specific features of communication with relation data base, we implemented the Instrumental Prolog-based package KEY for building natural language information systems. This package allows to built natural language information systems by naive users, who are specialists in problem domains, but have no experience in programming and designing NL information system. Created systems are based on small data bases (the restriction on small data bases - number of attributes are less than 20, number of records - less than 3000).

Using instrumental package KEY the naive user enters in dialog the name of data base, the number of data base attributes. To create data base user fills two forms. He enters to the first form the attribute's types of his data base and the attribute's names. In existing version of package KEY the attribute's type may be string or integer only . To the second form user enters the attribute's value according to the attribute's type. Simultaneously the system automatically writes the names of attributes and values of string attributes in special file DICTIONARY.

To extend DICTIONARY user fills two forms. Entered words to first form are the different synonyms of attribute's values or another words which can be used instead of attribute's values. To the second form user enters only interrogative words or synonyms to attribute's names, which can be used in future inquiries. Such words as "how many", "more", "less" automatically are added to DICTIONARY.

Then the package KEY automatically generates natural language information system according to user's problem domain and user's dictionary. After that different users may communicate with created data base on natural language. It is possible to enter new records to created data base and to enter new words to the dictionary. We have three variants of package KEY - in Russian, Ukrainian and English. The distinction is only in messages in windows (in russian variant - russian messages, in ukrainian - ukrainian messages and etc.). KEY - package is domain-independent and language-independent.

We have some systems, which were built using the package KEY : system FLIGHTS (this system was built in co-operation with Hungarian specialists from computer research and innovation center) and system STUDENT.

FLIGHTS problem domain contains the information about routes of flights between European cities. Languages for communication - Russian and English. STUDENT problem domain contains all information (there are 18 attributes in data base) about students from L'vov technical school.

Language of communication is Ukrainian.

We expect to extend the possibilities of package KEY in the way of creation more complex data bases and more flexible linguistic analysis of NL inquiries.

KNOWLEDGE ACQUIREMENT IN THE PROCESS OF WORK WITH THE PROBLEM-ORIENTED SYSTEM FOR GENERATING INFORMATION SUPPORT AND SOFTWARE

B.B.ZOBNIN
Ural Mining Institute
75, Phrunze str., apt. #139, 620144 Ekaterinburg, Russia

Keywords: problem-oriented system, and/or tree, computing experiment, mining enterprise

The existing system of training engineers-technicians, application programmers, designers, technologists in a number of higher schools is aimed at providing the user with software support for the solution of a particular group of problems.

The orientation to a particular group of problems doesn't allow the programs to be flexible enough according to the changes in the information support and requirements to the results of the solution.

The alternative to task design is the creation of problem oriented system on the natural language of the domain permitting to generate information support. An important stage in creating problem oriented system is the transformation of domain description which is given by technological sciences into mathematical models.

It is obvious that the teaching process should be planned in such a way that the students would take an active part in creation of mathematical models and their conversion according to a particular technological situation.

Regularities described by technological sciences may be illustrated as a system of productions and also as base models which are to be converted.

In common case production systems are written down as follows [1].

M: J: L -> B, b

where M - domain of this particular algorithm;

J - conditions in which this algorithm works

L - precondition

B - operation, finding, enguiry

b - condition, modifier of J.

In the simplest case it is an instruction < > if a condition < > then the operation < >. In more complicated cases it is a static or dynamic statement connecting input and output variables.

Problem-oriented system describing domain includes database and knowledge base, graphic and language processors of library function, including for instance, the choice of approximate polynoms and library of functional procedures such as forming and checking geometry simulator of conditional code.

Teaching in the working process with the problem-oriented system may be illustrated by the example of solution the task of making choice between different methods of mining a mineral deposit.

The methods of mining and the capacity of the mining enterprise are determined by the following factors:

- Geological (ore reserves in the deposit, percentage of useful components in the ores).
- Miningtechnical (the depth and peculiarities of ore occurrence, hardness of surrounding rocks etc)
- Technological (mineralogical and chemical ore constituents, grain size of ore forming minerals etc.).
- Economical (the cost of mining, demands in this particular raw material and so on).

Consulting the database and the knowledge base a student must choose methods of ore processing and illustrate them by and/or tree [2] And-nodes correspond to a particular production subsystem (opening up of the deposit, mining the deposit, ore processing) or - nodes correspond to alternative variants of subsystems.

The choice of alternative variants is made taking into account knowledge accumulated in the knowledge base expressed as production rules.

The effectiveness of each or-node is estimated by a complex of criterions with the help of computing experiment. Different cost estimates can be used as criterions namely: mining differential rent which makes it possible to choose the best deposit for industrial mining judging by labour productivity in particular natural conditions, profitability of capital investment etc.

The type of the computing experiment may be illustrated by the estimation of ore reserves in the deposit. The raw data for the estimation of ore reserves is the percentage of useful components which can be obtained by prospecting drilling. These data are discrete random chains among which we should chose low rate components corresponding to the level structure of the geological field. To estimate the size of the reserves it is necessary to calculate the areas in all prospecting cross-sections of the site, limited by smoothed random chains and lines corresponding to given limits: the minimum industrial percentage of useful components in the ore, the minimum profitable content etc.

Changing in the interactive regime the parameters of filtration of random chains and level limits, the user evaluates pessimistic and optimistic estimates of ore reserves in the deposit corresponding, for instance, to different levels of detailed prospecting.

Thus, in the process of student's work with the problem-oriented system, active mastering of the knowledge, accumulated in the domain takes place. This is provided at the stage of and/or tree synthesis, at the stage of computing experiment, giving an opportunity to estimate possible alternatives from the point of view of a complex of criterions and at last making decision taking into account relative significance of some criterions.

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AN ACTIVITY APPROACH FOR ELABORATION OF THE EDUCATIONAL SOFTWARE IN PHYSICS REALIZING

GENNADY A. ATANOV
Donetsk State University
4, Boulevard Shkolny, apt. #89, Donetsk, 340015 Ukraine.

Keywords: education, software, physics, activity, skills, test, knowledge base, frame, pupil model.

In physics computers are used for demonstrations, modeling of processes and phenomena, treatment of experiment, examination and other. A lot of different programs are created, among of them there are both the large information system with which it is necessary to work for a long time and fragmentary programs wording for some minutes. In our opinion now the main problems are an adaptation of programs to the real instruction process, definition of such character of the software and such technology of its application that the biggest training effect could be received.

The final aim of the instruction is to work out abilities and the use of computers just with this purpose can be the most effective. Such approach should call the activities one. We have formulated the following demands to the educational software in physics realizing the activity approach:

1. A computer doesn't substitute any teacher. It is an additional educational means that, on the one hand, carries out some routine work and, on the other hand, opens new possibilities.

2. The programs make up a packet enveloping the whole course and leading the only line.

3. The use of computers doesn't essentially change the available instruction process, the whole course of physics must have from 15 to 20 the computer lessons.

4. Any pupil works with one the program while one the whole lesson.

5. Such lesson is the final one after studying any topic or section.

6. The program supposes carrying out a definite task or work and it is an abilities test.

7. The program allows to do the task to the pupil with any preparation degree.

8. All the numerical data of the tasks work out by chance.

9. The program sums up the work for any pupil and treats the results for all the pupils statistically.

The programs, in which the task is given as a reverse problem when it is necessary to find the value of any parameter in order to reach the put purpose, have the most effect. As a rule, the answer test fulfilled visual, the program demonstrates the course of the process or the phenomenon, the action of the installation and other by parameters being put by the pupils.

As the practice shows, without any help such task (let's call it the general task) can be carried out only by separate pupils. Therefore the general task is divided into some subtasks the successive implementation of which leads to the fulfillment of the general task. Each subtask has prompts of three levels: (i) idea or principle, (ii) the implementation way, (iii) the answer or a result that is near to the answer.

The programs allow to realize the principle: to learn from one's own mistake since they give a wide field of action for the pupils independence, acceptance of decisions by them. The program has the imitation mal-rules pupil model, it analyses the pupil's mistakes and, according to the reason leading to the mistake, organizes a necessary dialogue. For intensification of this effect the program should have the task where there is the large probability to do a mistake for the pupils. This circumstance has the most didactic value.

The program of summing up allows the teacher to get the integral picture of skills along all the group and correct his account of the instruction material if it is necessary.

The knowledge base of the program has the prompts, the active prompts, the inquiry data, texts and pictures introducing the pupil into the solution. The frame form of representing knowledge is best suited to realizing the above approach. The frames of two forms are introduced - the active ones and the passive (or information) ones.

The described approach permits to make clear and intelligible any physical phenomena for the pupils, raises their interest to the subject being studied, develops skills of their independent creative, activity, prompts durable mastering of their knowledge. The pupils have a great pleasure working with such programs.

THE PROGRAM OF THE PHYSICS COURSE AS A PUPIL MODEL

GENNADY A. ATANOV, NATALYA N. MARTYNOVITCH,
VALENTINE V. TOKIY.
Donetsk State University
Donetsk, 340015, Ukraine

Keywords: education, program, physics, knowledge, skills, test, diagnostic, pupil model.

Development of the new instruction technologies practically does not affect one of the main element of any subject - its pro- gram. As a rule, the program represents an exposition of the manual contents. Its main purpose is to reflect the structure of the science that is the subject object. Perfecting the education demands representing not only about paragraphs, topics, or sections that are studied in any subject. It is important to have more detailed structure with point of view of strictly knowledge and skills.

The generally accepted approach of the modern instruction technologies is using the pupil model. In narrow sense, this is a list of knowledge and skills that must be acquired by pupils. The model will be the most general one when it includes all positions of the subject. Such model can be put at the basis of the subject program. In this case the program will be a binding section between the subject and the pupil being instructed in this subject.

The described approach was applied to building the program of physics for the technical higher educational institutes. The program consists of two the main parts - the information base and the skill list. The information base, in its turn, consists of the subject structure and the knowledge list. In the subject structure there is only a list of the main topics and questions being been subjects to examination without any detailed deciphering their maintenance. The necessary detailing is given as a list of knowledge. Knowledge are differentiated by structure accordingly to the following heading: determining notions, wordings and consequences, conclusions, proofs, equations, formulae, properties.

The skills theory is elaborated worse as compared with knowledge but just the skills are the final aim of studying. Three kinds of the skills distinguished: the general, the concrete, and the experimental skills. In first turn, the methodological skills belong to the general ones, for example, to analyze the processes and phenomena, to build the physical and the mathematical models, to reveal contradictions between the theoretical generalizations and the processes coursing in the nature, and so on. The spectrum of the concrete skills is much wider, in the program there are them more than 200. Accordingly to the educational material of all the course, the following skills are distinguished: to find, to define, to build, to calculate, to evaluate, to discern, to distinguish, to choose, to to take into account, to to present, to cross, to decompose, to make up, to generalize, to apply, to make use, to formulate, to illustrate.

The experimental skills are: to measure different values; to reproduce processes and phenomena; the others, for example, to observe phenomena, to determine the accuracy of the measuring, and so on.

The use of the described program will make lighter: putting connections between the knowledge and the skills being determined by them, creating the knowledge bases and the pupil models for studying the different topics and sections, elaboration of the test and the diagnostic means of both knowledge and skills.

COMPUTER MODELS OF COGNITIVE PROCESS IN MUSIC

ALEXANDRE GEIN & VLADIMIR TSEKHANSKI
Ural State Conservatoire, Ekaterinburg, Russia
E-mail:volkovm@urgu.e-burg.su

Keywords: cognitive models, computer models, computer recognition, musicology.

Computer modelling of music events not confined to primitive translating of the well-known musicological rules into mathematics terms but based on a systematic analysis of music structures perception has at its base the notion of attraction formally manifesting itself in increased probability of these or those music element complexes' appearance. This approach sets the grounds to apply statistical methods to study relations and connections between various music elements. However, a study of even simple, in their sonic and rhythmic arrangement, music compositions cannot be confined to just statistical analysis. Every composition has a definite content legible for the audience.

To induce this content, psychological mechanisms, permitting the individual to select, combine, compare and classify music structures on the basis of musical and aural images, are formed in the process of musically perceptive ontogenesis. Hence statistic approach to music events modelling must be supplied with corresponding cognitive process modelling.

We have developed methods to construct computer models of cognitive process taking places during recognition of metrical and tonal structures of a music material. At first, by questionnaire among musicology experts, generating factors for these structures were pointed out. After that, each of these factors was connected to a set of statistically reckoned parameters acting furtherupon as recognizing function arguments. The recognition of the meter or the key of a music fragment was performed by choosing the structure for which the recognizing function assumed the maximal value. At the same time, this function permitted to value the degree of influence of each factor on the recognition of the structure.

The realisation of the explicated approach permits to construct the whole class of recognizing functions. In fact, every separate function manifests itself as a certain mathematic model of the recognized structure. Assume that the function models the recognition process if the following two conditions are fulfilled.

i) Define the scale for measuring of recognizeability of meter (key) in the musical material, setting, as a measure for every variant of structure, the frequency in which this variant is pointed out by qualified listeners. The values of recognizing function set another recognizeability scale. The first condition consists in the two scale being connected by a monotonous transformation.

ii) As well-known, recognition of meter, rhythm and key structure by a listener usually takes place long before the audition is completed. Thus, the second condition is to bring closer the recognition moments of a human being and a computer.

From the key-recognizing function class we managed to choose one satisfying the mentioned needs for 88% of music fragments offered to a computer and a group of experts. This is to certify a sufficiently high adequacy of the constructed model of recognition. In the remaining 12% a man would recognize a key sooner than a computer did. This proves existence of additional psychological mechanisms not accounted in the given model.

Modelling of musical structure is a base for creation of effective computer educating programs permitting the students to study musical notion not in training but in a quest mode. However, the

right formation of quest strategies is possible only on condition that the education program comprises a cognitive process model. Thus the constructed recognizing function is a model kernel of all the musical educating programs created at the Urals Conservatoire.

SUPPORTING A COACHING SYSTEM WITH VIEWABLE LEARNER MODELS

N. PARANDEH GHEIBI & J. KAY
Basser Department of Computer Science
University of Sydney, Sydney, Australia
E-mail: noroja@cs.su.oz.au, jkay@sarad.cs.su.oz.au

Keywords: learner model, individualised teaching, inspectable systems, explanation.

An Intelligent Teaching System (ITS) individualises its teaching on the basis of a model of the learner. We have been evaluating the use of this model as a teaching aid.

Normally this learner model is updated as the system's view of the user changes in response to the learner's interactions with the system. Typically, this learner model is notaccessible to the student it models. We have constructed an interface that supports the learner in viewing their model. It enables the student to see a full overview of the model as well as detailed views. It also allows the user to alter the values in it, see explanations for aspects of it and view the systems justification for the model's contents.

We are interested in the way that people can be helped to use computer tools more effectively. This is not typical of much research in intelligent teaching systems in that our learner shave no reason to learn about these tools for their own sake. They mainly view them as a means to achieving other goals.

We have conducted an experiment involving 342 second year computer science students. We provided them with coaching advice on the main text editor that the class used for their assignments for a year and a half.

We allocated students into four groups on the basis of a digit of their student number. This gave a random distribution of performance in the first year of Computer Science. The groups are:

Group 1: 109 were in the control group and received no coaching from our system

Group 2: 82 were given fixed advice

Group 3: 79 were coached based on their student model

Group 4: 82 were like group 3, except that they were invited to view their student model.

The coach sent each student in Groups 2-4 two mail items each week for 8 weeks. We monitored their use of the editor up to the beginning of the coaching and afterwards to assess how many aspects of the editor they appeared to use competently. Table 1 gives a simple summary of the number of commands learnt by each group.

TABLE 1. Summary of number of commands learnt by each group

Group	Average Commands Learnt	Variance
1	1.3	1.4
2	1.7	1.4
3	2.0	1.3
4	2.3	1.5
4	2.8	1.2

The first four rows show a progressive over the groups.The paper discusses the interpretation of these results, taking account of the context of the experiment and with the aid of follow up interviews. Essentially comparing groups 1 and 2 indicates the effect of our coach. The difference between groups 2 and 3 reflects the utility of a user model for a coach. Finally, the difference between groups 3 and 4 indicates the effect of allowing the learner to see their model.

The last row of table shows the number of commands learnt by those students in Group 4 when they had made substantial use of the viewer program. From the group who had access to the viewer (Group 4), only half did use the facility. Among those students, 30% used it more than average usage, 68% used the evidence giving facility, and 69% used the command explanation facility provided by the software. The average number of commands learnt among these students is shown as 4 in the table. This suggests that the use of the viewer facility increased the average number of commands learnt.

To put these observations in context, the paper discusses the use of monitor data for constructing learner models for simple coaching systems such as we used in this study. We explore the aspects of this experiment that promise to be of broader significance. We consider the particular nature of our domain, where the learner is a discretionary client who decides what to learn and whether to learn, as well as the particular nature of the learner models we build and the viewing interface that we have used. The paper explains the context of these groups,describes the analysis of their use of the viewer and how this relates to the summary outcomes.

Our experiment supports the utility of a user model to drive a coaching system. It further suggests that some learners benefit from having access to the system's learner model of them.

PRACTICAL KNOWLEDGE DIAGNOSTICS

Theoretical system approach
VLADIMIR A. GOODKOVSKY
ENIKO 14, Moscow Institute for Physics and Engineering,
31, Kashirskoe shosse, 115409 Moscow, Russia

Progress of ITS theory, technology and practice is defined mostly by the degree of development of Knowledge Diagnostics theory, technology and practice. This important direction has been worked out lately by many researchers on the basis of different approaches.

First ideas of the Diagnostics in programmed learning has been manifested by Landa in 1966. Now there are the bug library technique (Brown and Burton, 1978; Burton, 1982; Jonson, 1986) and the machine learning approach (Langley, Ohlsson & Sage, 1984; Langley, Wogulis & Ohlsson,1990; Misoguchi & Ikeda, 1992). These approaches are based on detail reconstruction of student mental activity. As a result they are very complex and are not widely used in practice. The attempts to simplify these approaches for practical use was undertaken in the model tracing technique (Anderson and co-workers, 1990) and the constraint-based modelling technique (Ohlsson, 1993).

Common features of all above mentioned approaches are as follows:

- The worked out solutions of Knowledge Diagnostics problems are domain-oriented.
- Knowledge Diagnostics is studied independent of other more advanced branches of Diagnostics.
- Knowledge Diagnostics problems are being posed in particular, not in general.
- There are many heuristics and few formalisms in the posing and the solving of Knowledge Diagnostics problems.

At the same time perfect elaboration of Mathematical Test Theory, Pattern Recognition and Technical Diagnostics give the good analogies for break-through in Knowledge Diagnostics.

The main goals of our activity were generalization of known partial achievements in different branches of Diagnostics and development of domain-independent mathematical theory and technology of practical Knowledge Diagnostics. For our research we have chosen theoretical system approach. It has given us the following opportunities:

- To overcome traditional narrow heuristic style of numerous researches in Knowledge Diagnostics.
- To get up to high level of diagnostician's knowledge representations in theoretical system terms.
- To summarize known different achievements in any branches of Diagnostics on the mathematical system basis.
- To use modern theory of fuzzy sets, that is specially constructed for humanitarian applications.

In this we are agree with Petrushin (1992) in his Bayesian approach extensions.

In theory we have achieved the following results:

- Standard posing of Knowledge Diagnostic problems.
- Knowledge check problem.
- Single bug diagnostic problem.
- Multiple bug diagnostic problem.
- Knowledge repair problem.
- Individual traits diagnostic problem.
- Fuzzy mathematical forms of diagnostic student model (this is declarative knowledge of a diagnostician).
- Mathematical methods of knowledge diagnostic problem solving in passive manner of diagnosing (this is procedural knowledge of a diagnostician).
- Estimation of current diagnostic quality of possible diagnostic experiments (tasks, questions,etc.) for active diagnosing.
- Algorithms of passive and active diagnosing.
- Algorithms of constructing minimum check and diagnostic tests of predefined quality.

In technology we have developed:

- Procedures for building of applied diagnostic student models by experts.
- Procedure for verification of applied diagnostic student models.
- Batch, consequent, branched procedures of student's knowledge diagnosing.
- Remedial procedure.

In practice worked out theory and technology was used for design of check, diagnostic,remedial and tutoring services in ITS in different domains.

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SIMULATION OF OPERATOR'S ACTIVITIES IN THE INTEGRATED LEARNING SYSTEM

N.N. HUSIY, I.N. GLUCKYCK

Institute of Civil Aviation Engineers, Kiev, Ukraine

The conception of computer technology for teaching operator's for complicated technical systems with human participation is based on the using of functional trainers *(FT)* and integrated expert systems in the process of study.

Such system contains in itself the model of controlled object and imitation model of operator's functioning *(IMO).*

Some facilities in conducting the activities of the operator in the extreme cases of handling the control are due to such models which from form part of the *FT* and provide a convenient usage interface.

The ideas given here are used for imitation of the activities of a person, whose job is the handling of air traffic control *(ATC).*

The model of *ATC* operator's activity may be represented as two-level hierarchy structure: the higher level with coordinating center *Co;* the lower level - with controlling elements C_i.

The i-th object can be characterized at the *i*-th moment with the following conjunction of vectors: $W_{ik}=w_{ik}w^{1}_{ik}$

where $wik=<x_{ik},y_{ik},z_{ik},t_{ik}>$the object coordinate vector;

$w^{1}_{ik}=<x^{1}_{ik},y^{1}_{ik},z^{1}_{ik},t^{1}_{ik}>$the object speed vector.

The coordinating actions of the center give for each object the meanings of coordinates for boundary points an trajectory lines $F_{im}[x_{im}, y_{im}, z_{im}, t_{im}]$, i.e. the center C_o performs the transformation $C_o: P\{W_{ik}: i\} \to \{F_{im}(t_{im} > t_{ik}) : i\}$. The aim for C_i element is reduced to the production of controlling actions of the form $w_{ik} \to f_{ik}$. Here $f_{ik} \in [F_i(m-1); F_{im}]$

The number of the points, belonging to the trajectory of the present plan and their coordinates in the general differ from the ones given earlier. That is due to the fact, the *ATC* man corrects when necessary, for the sake of the security the preliminary flight plan.

The security requirements are fulfilled under the next conditions:

$f_{ik} \notin Dj$, $k=n,(n+ts/dt); i=1,N$; $j=i+1,N$,

where n - is the number of the discrete counts of the time at the moment of observation;

ts- the time-security interval at which there is yet a possibility of potentional conflict elimination with the help of the changing of trajectory movements for conflicting objects;

Dj- the set of the points for the conflicting area of the j-th object. The radiolocation minimums of the leveling define the borders for conflicting area.

There is a necessity of vector speed changing at the $ti(k+dt)$-th moment (if the given above condition fails) and the object positioning at the point $F_{sl}[x_{sl}, y_{sl}, z_{sl}, t_{sl}] \notin Dj$ at the time $t_l = ti_{Dj}$

There may be two directions in further operation of the model and two types of imitational models for objects. The first directional suggests the presence of plan-generator block in the sphere of Co. There is a complete recalculation of border points for trajectory movements on the base of extrapolation and minimization of waste control factor J, when solving the potential conflict situation in such model. In the second case the preliminary plan (chart) remains untouched, and the line $[F_{ik}; F_s(k+ts/dt]$ is formed at the conflict part of trajectory at the moment of possible conflict. When the point $F_s(k+ts/dt)$ is reached by the object, the supervision functions by the element C_i are performed as follows:

if $fi(k+dt) \notin Dj$

then $w_i(k+dt) \to f_i(k+dt)$

else $w_i(k+dt) \to f_s(k+dt)$

where $fs(k+dt) \notin Dj$, $j=1,N$ and $R(f_i(k+dt); f_s(k+dt)) \to 0$;

$R(x,y)$ - a distance between the points x and y in the n-measured area.

The realization of *IMO* of the second type is free of those considerable difficulties, which accompany the first model construction variant. The model of this type can be used at the same time as the basic model for elaboration of more perfect imitation models. It can successfully be applied to the expert learning system with the aim of gaining the necessary knowledge and experience when conflicting situation arises in the *ATC* system.

ADAPTIVE TESTS FOR ENTRANTS OF THE UNIVERSITY OF KIEV-MOHYLA ACADEMY

KATHERINE M. SINITSA [*], VALERY A. PETRUSHIN [*],
VICTORIA V. ZHERDIENKO [**], AND SERGEY T.ADRIANOV [*]
(*) Glushkov Institute for Cybernetics, Kiev, Ukraine
(**) University of Kiev-Mohyla Academy, Kiev, Ukraine
E-mail: KATH%ITSLAB.KIEV.UA@relay.ussr.eu.net

University entrants to the Natural Science Department pass exams on four main subjects - Mathematics, Physics, Chemistry and Biology. These exams are held in a form of score-based

written testing. Our task was to construct computer-based adaptive tests for entrants knowledge level assessment and estimate their applicability.

A special software tool, named CONTRAST, was constructed, which comprise

- Supervisor/Manager - for user registration and statistics calculation of tests results.
- Editor - to prepare texts, pictures, animation and set parameters.
- Executor - to organise adaptive testing, using tasks from Subject Data Bases.

Adaptive mechanism as well as decision making is based on Dempster and Shafer theory [1] and used techniques described in [2,3]. The solutions of tasks of various complexity are considered as evidencies to hypotheses about entrant knowledge level. Independence of evidences, that is the necessary condition to apply the theory, holds as the tasks are chosen from different themes whithin a subject.

This year entrants were proposed to evaluate their knowledge level by adaptive computer tests after passing formal tests. The aim of this experiment was to find best forms and types of tasks for every subject, to find an appropriate form of user interface, to evaluate the acceptance of adaptation mechanism, to define number of auxiliary tools that may be useful for task representation and solution, to define methods for knowledge evaluation that are useful both for teacher and student.

The statistical results received in this experiment will be represented on poster. The qualitative results of this experiment are as follows:

- Results of knowledge level assessment are accepted by teachers and most of entrants.
- Entrants enjoyed the using of adaptive tests for self-assessment, but they need more detailed feedback.
- Entrants would like to use this kind of program for training, extracting the information about correct solution and taking the protocols home to think and discuss.
- Some entrants prefer to make their own decision concerning theme and complexity level of the next task.
- The adaptation mechanism seems to fit both testing and training mode. The tasks are chosen in the direction "from simple to complex", that corresponds to the entrants choice "from mastered to less known" subject.

As this form of testing was new to the entrants, they could not use the advantages of multiple-choice answering mode. When using the program for training without time restrictions one should be allowed to constract his own answers and enter them (as chemistry reaction formulae).

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KNOWLEDGE-BASED SYSTEM OF QUALIFICATION ESTIMATING

O.L. SLABNOV, V.S. SCHPAK
ENIKO 14, Moscow Institute for Physics and Engineering,
31, Kashirskoe shosse, 115409 Moscow, Russia

Keywords: advice, diagnostics, estimating, forecasting, knowledge base, logical inference, object-oriented, production rule, statistics, training, qualification

Before organizing effective control of training process, creating developed training systems and tools, providing qualitative training of personnel it is necessary to answer the common questions: "What does qualification of specialist mean?", "How can it be estimated?". The formal approach to solving this problem shows the heterogeneity of qualification aspects, the complexity in application of probability methods and other some difficulties. To get over it we designed sufficiently multipurpose system of qualification estimating (QES).

We suggest the approach with the following statement of a task. On the base of domain expert estimations of different qualification aspects, results of specialist testing with procedures allowing to determine his psychological and psychophysiological characteristics, estimations obtained from different training tools and systems (such as CBT, ITS, simulators, etc.), it is necessary:

- To obtain the impartial information and sufficiently explicable conclusions about specialist qualification.
- To diagnose the causes of low-level qualification and unsuccessful activity of specialist.
- To produce the advices of eliminating the elicited causes.
- To determine the numerical goal state of qualification and to obtain qualification estimations which can be effectively used in decision making of training process control.
- To forecast the subsequent qualification state changes.
- To accumulate the statistical data about dynamics of estimation changes obtained from both different sources and inside system.

QES software functionates in one of three modes: as environment, as shell and as application. It supports the following functions:

- Editing the learner qualification model (QM) representing hierarchical frame-based structure.
- Editing the knowledge base containing networked production rule models on which the logical inference on diagnostics, production of advices and forecasting is being realized.
- Estimating concrete learner on QM base by expert.
- Collecting estimations from different computer-based training systems using the program interface with QES or/and by hand.
- Obtaining learner qualification integrated estimation and advices about his possible usage.
- Testing learner with series of internal or/and external procedures (for example, to determine the psychological and psycho-physiological characteristics).
- Diagnosing causes of low-level qualification and unsuccessful activity.
- Producing advices on elicited causes eliminating.
- Accumulating statistics about all processes taking place in QES and visualization of their dynamics.

QES functional scheme is displayed in Figure.

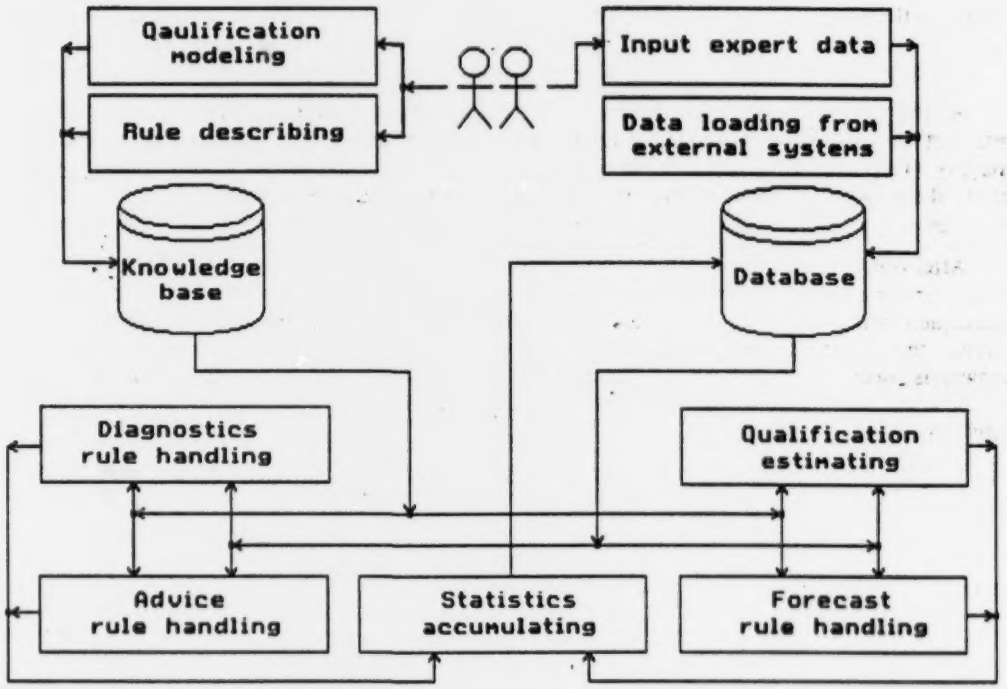

Figure. QES functional scheme

Necessity of all above-mentioned system functions stand exposed in QES experimental commercial exploiting on nuclear power plant.

QES allowed to create the computer-based support integrated complex of training process and is its nucleus now.

QES is realized in object-oriented paradigm on C++ language in MS-DOS (v5.0). It uses DBMS Paradox and is oriented on PC-AT/286/386/486 series.

QES is designed into frames of "Intelligent Tutoring Systems" project in "ENIKO 14" firm which is included in "ENIKO MEPhI" joint -stock group.

SELF-CONTROL ORGANIZATION IN THE PROCESS OF TRAINING

A. A. STASOV
Voronezh Technological Institute
19, Revolution Ave., 394000, Voronezh, Russia

Keywords: computer training, educational process, key word, self-control, test

Computer training effectiveness depends to a considerable extent on the students' own work and self-control, their needs and abilities for self-appraisal and self-training being necessary to form. When organizing self-control the students' activities strict regulation is inadmissible; they must be given a free hand that, however, doesn't exclude the issue of the recommendations and advice being not obligatory for performance.

When using self-control the students choose the control tests themselves following the self-appraisal of their knowledge. It's difficult to do from the display screen where not more then one task can be found at the same time. Placing the hard copy of all the control tasks being in the computer at the students' disposal is the outcome from such a situation. Only the test questions must be typed.

All the tests are divided into three groups. The first group includes the tests of a lover difficulty intented for the first acquaintance or for the weak-grounded students. The second group involves the tests of a conventional difficulty intented for a student of average abilities. And, finally, the third group of the tests is of a higher difficulty; they have no direct answers in the textbooks; their solution requires the non-trivial approach and the logic reflection. Every tests is provided with its own code.

After obtaining the code of the chosen test the computer shows the contents of the test on the screen and helps to find the appropriate form of the answer under necessary conditions. The subsequent computer operations depend on the correctness of the student's answer. If the answer is correct, the student gets the confirmation and the possibility of transfer to the next test. When the answer is incorrect, the computer reacts according to one of the following versions taking the peculiarities of the test, the degree of its difficulty and the number of unsuccessful attempts into consideration:

1. The student is simply given the possibility of a new attempt.

2. The additional test is given.

3. The deliberately surplus set of key words is presented. Using a portion of them it is necessary to construct the correct answer.

4. Help reminding some theoretical propositions is put out.

5. It is pointed to the necessity of studying the corresponding literature.

6. By pressing the special key the student can ignore any computer operation and transfer to the next text.

The preliminary placing of the control tasks typed text at the students' disposal allows them to prepare the answers in advance using the educational literature when necessary. Thereby the time of the students' direct work with the computers is reduced that is not the least of the factors in the conditions of their deficiency. In addition of this, as the sanitary research showed, the prolonged work with the computer leads to the undesired changes in health, therefore the permissible working hours with the computer are limited. The student can prepare for self-control anywhere outside the computer classroom and at any free time.

It is possible to add to the students' self-control programme the control block giving a mark, that will help the students to learn appraising their knowledge more unbiassly.

Thus the considered self-control scheme is not limited only by the purely control functions but it involves the elements of the educational process as well.

UPDATING THE STUDENT MODEL

YURY V. TSYBENKO
Intelligent Tutoring Systems Lab
Glushkov Institute for Cybernetics
40, Prospect Akademika Glushkova 252207 Kiev, Ukraine
E-mail: tsybenko%itslab.kiev.ua@relay.ussr.eu.net

Keywords: intelligent tutoring system, student model, diagnosis, conflict.

An Intelligent Tutoring System *(ITS)* knowledge is usually described in terms of belief. Some of this beliefs may be default assumptions about student: student knowledge, student skills, stereotypes of student behavior. Other beliefs the system obtain directly by observation. Proceeding

from this information the *ITS* makes inferences about the student [Petrushin, 1992], [Huang and McCalla, 1992]. So, a student model also contains information inferred from existing information. The formal approaches to student modeling have been treated in [Self,1990].

When an intelligent system obtains new information from observation or inferences the new information may conflict with the old system beliefs. For instance, during the educational process the student's knowledge augments, consequently the student model must be updated. The student model also requires updating when the *ITS* encounters evidence that the student acts differently to the way the student model would predict. When the new information does not contradict the system beliefs it may be added to the system belief base. Otherwise the system must determine and remove some elements of belief base which lead to inconsistence.

In this paper we study a model-based approach to the student modeling. In accordance with [Reiter,1987], a system to be modeled is described in terms of *SD* axioms (first order sentences). The system components may be normal and abnormal. In our case that means that status of beliefs from the student model may be accepted and rejected. A diagnoses is a set of assumptions being rejected restore consistency of system description. Minimal change is commonly regarded as a principle of belief revision [Dalal,1988]. If we have to change our belief to accommodate new information, we want to retain as many old belief as possible. So, minimal change entails the minimal diagnoses provided by Reiter [Reiter,1987]. There may be a lot of competing minimal candidates. To filter out multiple explanation of a default theory van Arragon [van Arragon,1990] uses a priority assigned strategy. Huang [Huang, 1991] develop this approach. The other way to determine the actual candidate is to make additional measurement. de Kleer and Williams in [de Kleer and Williams, 1987] develop an approach based on probabilistic analysis to determine the best measurement which help to localize the most probable diagnosis. McIlraith and Reiter [McIlraith and Reiter,1992] use measurements in order to confirm or reject possible diagnoses. As it is shown in [Tsybenko, 1993] non-empty measurement outcome always prunes the diagnoses set. But in the case of minimal diagnoses the results of measurement not only refute some minimal diagnoses, but can lead to the appearance of new ones.

The notion of conflict is a basic notion for model-based diagnostics. A conflict represents discrepancies between observed and expected behavior. Informally, a conflict is a prime implicate entailed by system description together with new information.

Any real system being modeled has simple correct diagnosis, namely, the set of system faulty components. The elements of this diagnosis do not depend on the measurement outcomes: any measurement must confirm the diagnoses. In the case when there is one and only one minimal diagnosis, we can choose it as the actual diagnosis of the system. In accordance with [Tsybenko,1993] the system has one and only one minimal diagnosis iff each minimal conflict entails by system description consists of one element. Let us consider the notion of actual diagnosis elements of which are preserved in case of possible measurements. Define *UOBS* is the set of results of all possible in the given model measurements.

Definition 1 An actual conflict of the given model M is a prime implicate of $SD \,\&\, UOBS$.

Definition 2 An actual diagnosis D_{act} for the given model M is a minimal diagnosis with the property that for each element of D_{act} there is an actual conflict of M containing this element.

It is important to note, that in order to obtain an actual conflict, there is not necessity to perform all possible measurements. We study methods of finding of the actual conflicts by performing the minimal number of measurements. But these methods are beyond the scope of this paper.

Finally, consider belief updating strategies. The systems similar to the *EBRS* [Huang,1991] perform diagnostics and belief updating whenever inconsistency is obtained. It may be cause an actual diagnoses lost. Our strategy of belief updating differs from above. We avoid fast shifting of the belief updating. Any new information only prunes diagnoses set. In order to obtain an actual conflicts we perform all necessary measurements. If any actual conflict consists of one element there is one actual diagnosis. Otherwise there may be few actual candidates.

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KONTUR: COMPUTER LEARNING ENVIRONMENT FOR STEREOMETRY

T. ANDRUSSENKO, N. LITVINENKO, E. SHEVCHENKO, I. STECENKO, A. STRIJAK
Glushkov Institute for Cybernetics, Ukrainian Academy of Sciences
40, Prospect Acad. Glushkova, 252207, Kiev-207, Ukraine

Keywords: learning environment, stereometry, cognitive explication, computer thesaurus, conceptual modeling.

KONTUR is a computer system which provides a task solving in the area of geometrical construction of the section of convex polyhedron and an active study of problem area. This program allows to solve any task from school course of stereometry. The condition of the task forms during the dialogue with the user. Graphic object models are created on the screen simultaneously.

During task solving the user works with the real objects of problem area (point, straight line, line segment, plane, polygon, polyhedron) using a wide list of graphic operations, various procedures of figure's rotation and a window's environment).

Computer means allow to visualize not only objects being studied, but also elements of the task solving: the construction of polyhedrons on the base of its components and features, and construction of the section of polyhedron by plane.

The peculiarity of this computer learning environment is the explication of user's way of reasoning while he or she describes the initial objects.

KONTUR allows:

- To fasten the skills of task solving (construction of the section of convex polyhedrons).
- To solve not standard tasks of this class and then to research them in order to find several solutions or particular cases of the solution which is already find.
- To control the user's knowledge.

The system navigates user's activity to the task solving. Cognitive model laying in the basis of the system reflects the real process of task solving, which includes two phases: preliminary (understanding of the task - formalization of the condition of task) and executive (task solving - construction of the section) [1,2].

This variant of computer learning environment realizes the both aspects of teaching activity - didactic and research. The positive psychological result of the utilization of computer learning environment for the user is that the user from the object of teaching turns to the subject of teaching [3]. The teacher coordinates the functioning of four main types of objects: the user, the task, the system and himself. The teacher was and remains the central figure of the learning process control.

With the help of KONTUR the user receives the possibility to build his own way of solution, including:

- Formalization of the condition of task.
- Research of the solution.
- Approach the object to the real one.
- Work with concepts on the base of thesaurus (in the ASKUN environment [4]); original tasks of problem situation modeling on the conceptual level.

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HUMAN TEACHER'S CONTROL IN AN INTELLIGENT LEARNING ENVIRONMENT FOR CALCULUS

VALERIA BRUSILOVSKY
Department of Applied Mathematics and Cybernetics,
Moscow State University, Moscow, Russia
E-mail: krl@plb.icsti.su

Keywords: intelligent learning environment, calculus, adaptive sequencing, teaching strategy.

Computer application to the learning process is most effective when computers and human teacher work in a co-operation joining their efforts. Such a co-operation develops by two ways:

- Human teacher should plan learning process to transpose some part of the work to computers. For example, human teacher gives some introduction, and students do their exercises with computer educational system.
- Computer educational systems should allow to be tuned in accordance to human teacher preferences. For example, teacher influences on the sequence of exercises posed to students. Such possibilities help human teachers to feel themselves more comfortable with computer educational system.

This report presents an intelligent learning environment for calculus, which currently supports the work of the student who wants to acquire derivation skills. Special attention is devoted to the problems of the human teacher's control of the learning process.

The intelligent learning environment for derivation (ILED) is designed as a friendly computer environment for a student who wants to acquire the skill of derivation (Brusilovsky, 1990; Brusilovsky, 1993). The environment consists of the structural editor for formula manipulation, two teaching components (strategy tutor and coach) for learning process support, the domain expert for derivation, and the student model to reflect the current level of knowledge and skill of a student. The student works with the structural editor which supports formula manipulation, under surveillance of the coach. Both teaching components use the student model for the purpose of adaptation, and the coach supports its actual state.

The student uses the structural editor to work with a concrete problem of derivation, that is, with a certain expression. The student may process any expression: either devised, or taken from a problem-book, or received from a human teacher. The learning process is more effective when the student asks the strategy tutor for a recommendation. Taking the student model as a basis the strategy tutor chooses or generates the required expression.

For each separate skill being mastered in the learning process, the student model stores the number, reflecting the probability of the correct application of this skill. Most of the skills reflected in the student model are the derivation rules for arithmetic operations (such as $(u+v)' = u'+v'$), for functions (such as $(\cos x)' = -\sin x$) and the special set of the rules for complex function derivation (such as $(\cos(u(x)))' = (u(x))' * (-\sin(u(x)))$). The tutor selects the goal set of rules according to the

student model state and constructs or chooses from the file of problems one expression for derivation (posed to student as one problem) which involves all the rules of the goal set and only them. The goal set of rules should be an optimal (for the given student at that given time) mixture of derivation rules of the different mastery levels. The number of rules in the goal set should depend from the ability of the student to tackle cumbersome expressions.

To influence on the teaching process the human teachers can correct the system file of problems (for example, add their favourite problems), and set a personal sequence of lessons for a student in the file of strategy. Each lesson in the file is a set of derivation rules. The strategy tutor reads this file and includes into the goal set of rules the rules from current and precedings lessons only. At the moment when all these rules are well-known for student the next lesson is appended. Such a technique permits to create the different course of teaching with the same learning environment.

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ELECTRONIC TABLE SHIFTING ACCORDING TO DATA

A.V. BULAT, M.S. LVOV, V.G. MARINCHENKO
Department of Informatics & Computers
Kherson State Pedagogical Institute
27, 40 let Oktyabrya str, 325000 Kherson, Ukraine

Keywords: computer calculations, education, mathematics.

INTRODUCTION

The main aspects of program environment design -SCHEME- are studied in this article.

The main purpose of the system is the computer support of the process of the mathematical task solution, which is connected with the numerical calculations and making graphic illustrations of these calculations.

The example of such task is the solution of the transcendental equation by the simple iteration.

The system was designed as the support to the course "Numerical methods" for the students of the higher schools but it can be used more widely.

THE SET UP OF THE TASK

The students work while solving tasks on numerical methods includes the making of data table, which contains the calculation results at the every step of this method (when using the same formulas many times).

The traditional computer methods include either using of the ready programs , which automatically generate the solution or the programming of the algorithm of numerical method on the one of the languages of high level by the student. Both these methods are not effective from the methodical point of view. The using of the ready programs does not give the student any new knowledge. The independent programming requires a lot of time and teaches mostly to programming.

The main aim of the teaching is the knowledge of the method and the ability to project the method algorithm using the theoretical material. The adequate representation of the knowledge about method and the form of obtained result has the great importance from the methodical point of

view. The interface makes the great influence on the perception and understanding of the doing work.

This is the task of the programming environment design SCHEME.

DESCRIPTION OF THE SYSTEM

The idea of division of the data and working methods with them make the base of the realization of programming environment SCHEME. The means of the traditional electronic table are divided into the Data Table (DT) and so called Calculation Scheme (CS). CS is the table of the named cells, which store the formulas. DT is the table, which cells store the data.

The size of DT is bigger then CS one and CS is applicable to the TD fragment in the real tasks. While applying CS to the TD fragment the fragment data are accessable. The calculation results according to the formula of CS cell gets back to the corresponding TD cell.

The notion of User Define Function (UDF) is introduced for easy operation. This allows to use the same CS "filled in" by the different functions.

The environment SCHEME consists of three main parts :

1. DATA TABLE - the window which reflects the sequence of the method steps in the form of the data table.

2. GRAPH WINDOW (GW) - the window which reflects the sequence of the method steps in the form of the graphic interpretation.

3. Description of the method which consists of:

- CALCULATION SCHEME - the electronic table of the special form, which contains the formulas of the method step and returns the result to the Data Table.
- DRAWING SCHEME (DS) - the sequence of the graphic commands, which illustrate the one time using of Calculation Scheme (one method step) in the Graph Window.
- USER DEFINE FUNCTION LIST.

The means of Calculation Scheme include :

- The mathematical operations and functions.
- The variables of two types : common (X,Y etc.) and connected with the position in CS (A:1 etc.).
- The UDF where the argument can be pure data as well as variables (f(D:3) , Left(x,y) , My(54.9) etc.).
- The names of the mathematical pure data.
- The literals (which are transfered to DT without changes. E.g. 'F(x)').

The means of Drawing Scheme include the drawing commands such as "point" , "line" , "function graph" etc. The arguments of these commands are the meanings of CS cells and pure data.

THE WORKING PROCEDURE IN SYSTEM

Analysis of the task:

- To define the formulas of the method step.
- To define the form of the graph.
- To define the initial data.

The design of the solution algorithm includes the design of some pairs of CS , DS, each defining the linear part of the algorithm. The transition from one pair to another corresponds to the fork of the algorithm and the repeated use of the same pair - to the cycle.

- To design the pair CS , DS it is necessary :
- To put the formulas in the CS.
- To introduce the sequence of the graphic commands, illustrated the one time application of the CS into the DS.
- To put the initial data to the DT.

CONCLUSION

Having completed the work with the system the student obtains the full information about the work done : the table of results of task solution, the algorithm project and graphic illustration of the solution located in the different area of the screen.

Thus, from our point of view , the suggested system is one of the perspective approaches to the solution of the problem of knowledge representation in the area of the numerical methods and the other areas of the mathematic.

SOFTWARE ENVIRONMENT FOR TRAINING IN COMPLEX DYNAMIC SYSTEMS

GEORGE GEORGIEV, SVETLANA STEFANOVA, IRINA ZHELIAZKOVA
Computer Science Department
Technical University of Rousse
8, Studentska str, Rousse, 7017 BULGARIA
E-mail: JEP2614@VARNA.BULPAC.BG

Keywords: practical skills, structural model, functional model, trainee's behavior, classes of tasks, architecture, author's language, technology

The growing complexity of contemporary systems has made currently used methods for their modeling unsuitable because good results in acquisition of practical skills are hard to achieve under the changed circumstances. This explains the strengthened usage of computers for modeling complex dynamic systems. This approach gives trainees a free access to the model of the system, made by the trainer and the ability to generate such a model by themselves.

The model of the subject domain consists of structural and functional submodels.

The structural submodels, known to us from the reviewed literature have the following disadvantages:

- They are based on interpreting the flow-diagram of the system only as a graphic image and on the assumption that the trainee's mental model of the system structure is correct or with a satisfactory degree of understanding.
- As a rule they refer to narrow subject domains and solve a limited class of tasks, like acquisition of skills and diagnostics of faults (Sophie) or controlling of systems (Stream);

In this paper we suggest a subject domain independent model of the structure of a complex system based on obtaining the overlay model of the trainee, the teaching dialog and the training strategy from the model of the system. So it is necessary that the model of the system structure include knowledge about the hierarchy of the system (with no limitations as to the number of hierarchical levels and the number of elements per level) and the structure and functioning of levels.

Actually the model of knowledge about the system structure is chosen to be a network of frames because of the easy maintenance and flexibility it provides. The knowledge about the subject domain is filled in the course of highly interactive dialog. Comparing the mental models of the trainee and trainer, providing help information about the possible sources of faults and trouble-shooting is foreseen in the process of training.

The functional submodel describes the causalities, determining the behavior of the system being simulated. More concretely said it consists of a set of relations, describing the dependencies among parameters, characterizing the simulated system or process. Relations can be defined by mathematical expressions, allowing arithmetic, algebraic and transcendent functions and derivatives for modeling of the static state and means for solving systems of linear differential equations of the first degree for modeling the dynamics. Faults in any system component can be programmed to happen at any time.

An author's language has been developed to help with the creation of these two models. A full description of it in the Beckus-Naur form is presented in the paper.

The models of the system's and trainee's behavior are built during the simulation session. All different states of the simulated process are recorded along with the reasons that caused the change - trainee's action or a programmed fault in a component, thus forming a graph. This makes it possible to estimate the trainee's behavior by comparing it to the behavior of an expert under the same circumstances, that is by comparing graphs. Having all values of all parameters makes it easy to visualize the system's behavior too - for instance by drawing graphs of relations of any two parameters.

One architecture of a software environment based on these ideas includes the following modules: a dialog manager, text and graphic editors, a graphical constructor and a simulator. The database for such an environment is composed of the following types of files: programs in author's language, graphical images, test and text images, history files.

This architecture allows performing of several classes of tasks:

- Discovering a priori unknown functional relations between para meters in a process.
- Building a structural model of a process and estimating its correctness.
- Exploring the behavior of a static system.
- Analyzing the transient processes in a system.
- Acquiring of skills for managing a system under both normal and abnormal circumstances.

The technology of using this environment by the two main classes of users (trainers and trainees) for performing each class of tasks are described in the paper.

The software product implementing the above described concepts is registered at the Bulgarian National Software Project Fund under No 1.034.01812-01 / 1992.

IMITATION OF EXPERIMENTS WITH DEVICES OF MACHINERY HYDRAULICS

A.GUBAREV, A.UZUNOV, T. AVERINA
Hydraulics Laboratory
Mechanic Machinebuilding Department
Kiev Politechnical Institute
KPI-1260, 37, avenue Pobedy, 252056, Kiev, Ukraine

Keywords: machinery hydraulics, device, imitation simulation, student

There is a logical connection between the students' interest and the quality of their education. This interest is supported clearly and well justified by results. In order to utilize the above aspect there are many difficulties in the teaching of machinery hydraulics specialists which will be made known in the following:

- The equipment for machinery hydraulics is expensive.
- In the laboratory there are some difficulties in creation conditions in order for the devices to work.
- It is not possible to study loading limit.
- There are some difficulties in observing fleeting processes.
- The students must have high qualifications to work with machinery hydraulics equipment.

In deciding specific tasks engineers use special or experimental plants and problem-oriented models. The students must have the experience in order to work on this special equipment and models.

We can receive new results if we will unite the experiment with simulation. As well as this we have a computer on which the students may design devices themselves. The students may observe the results of their decisions and this supports their interest.

For designing the device and setting the work's conditions the students must not have special qualifications because it is like children's construction toys. The result is defined by form connecting elements and the connection's possibility inside these elements.

This method of approach gives new possibilities in the students' study:

- The student may do the experiments without anybody's help.
- Any parameter may be observed without error in measurement.
- The student may study destroying processes in the device.
- Any device's element may be replaced very quickly.
- It is easy to change the condition of the work.
- Fleeting processes may be worked out in detail.
- There is the possibility to do more experiments at the same time.

The software of imitation simulation was designed in order to study devices of machinery hydraulics. This software holds dialogic work. The work includes the following:

- The student must create the description of the device and he must set the values of parameters.
- The condition of work must be set for the device.
- The work of the device must be observed by the student.

The student may move within every part of this work as he wants. There are some limitations. These limitations are defined by common sense and by the construction of the data base. The data base is hierarchical and subject-oriented.

In creating the device's description the student chooses the elements from the data base which he needs. But the possibility of choice is differentiated by the last choice from the data base. The number of elements and the number of connections between these elements are enough for building a wide class for the devices of machinery hydraulics. While the student is choosing necessary elements the software builds the mathematic description of the device.

In giving the work's conditions the student must do a description of control, external loading or external power. For this the student must choose the parameters and must set the values of these parameters or the functions with set arguments.

In order to observe the work of the device on the computer's screen the student must have chosen only observed parameters, the scale and the time of observation.

This form of work is possible because the models for every class of the devices were built like the kernel with the environment. The kernel's model describes the logic of the principle action's device and the environment describes the physical processes of the conditions' work for this kernel. The construction of the above model enables the student to receive the correct model after creating the description of the device. At the same time this model gives him the possibilities to change the physical parameters in wide limits.

AIR TRAFFIC CONTROL TRAINING SYSTEM

Y.P. KARPUSHIN, A.I. KIZILOV, V.V. NESMEIANOV
Kiev Institute of Civil Aviation Engineers, Ukraine

Keywords: air traffic control, controller, training system, simulator.

The controller is an essential and weak element of air traffic control (ATC) system. From 70 to 90% of all the system errors that do occur stem from human mistakes in attention, judgment and communications by controllers and their supervisors.

It is known, that up to 75% of the recorded human errors were attributed in the categories of low experience, knowledge and skill shortages, insufficient professional training. So, important aspect of the job-quality assurance is the increased attention paid to controller training.

There are currently few specific stages in prolonged professional training of ATC specialist from initial selection to certification and further, during the work on duty. ATC training is an area in which simulators have taken an increasingly dominant role. The usage of simulation is now a major factor in almost all ATC training.

Controller's training through simulator sessions comprises two separate though interrelated phases: basic training provides the trainee with the knowledge and skill base required to carry out his tasks; on-the-job training enables him to be trained in skills and techniques are applied for real job.

The general stages of the simulator usage are creation and running of the practice exercises, performance analysis. Nevertheless, there is no ATC simulator alone being able to provide the automation media for all necessary stages and training courses.

This paper will consider how all stages may be combined by an ATC training system to produce comparatively low cost, more flexible and effective training simulators.

Conceptual design for such training system is considered. ATC training system is built as a complex of the problem-oriented sub-systems. Each sub-system includes software, hardware, and methodical facilities.

The practical sample of design is presented. Presented training system is modular in design and has a flexible structure which may be transformed to the range of simulators by reconfiguration.

The system hardware includes the IBM PC personal computers and two sets of consoles, one for trainees and the other for instructors. Instructor simultaneously plays the role of "pilots" operating simulated aircraft through control units. Each pair of consoles, one for trainee and the other for instructor, may be housed separately, but is connected by the common computer and the voice intercom network.

The number of each type of console which make up the complete system determined by the training capacity regarded by the user and the mix of skills training. Transformation to the simplest simulator configuration enables the trainees to practice on their own with a computer in the roles of instructor and "pilots".

Partial listing of the functions and possibilities of ATC training system includes:

- Human-computer exercise preparation. These exercises may be done in different sectors and with different scenarios. Scenarios may be created copying exactly any local airspace, thus enabling trainees to be trained, not only in general skills and techniques, but also required for specific airports or ATC sectors.
- Flexibility of the simulation process involving different numbers of aircraft simultaneously. The intensity and workload can be controlled and gradually increased during a training course. Difficult situations can be deliberately generated for training and demonstration.
- Detection and report operational errors in controlled airspace. Exercise can be recorded and replied for debriefing purposes.
- Registration and recording of the effectiveness data of prolonged training of all developmental ATC specialists. Important purpose of gathering and maintaining recorded data is to provide individual management on training results, trends, progress, and problem areas.

AIST: APPLIED COMPUTER ALGEBRA SYSTEM

M.S. LVOV
Department of Informatics & Computers
Kherson State Pedagogical Institute
27, 40 let Oktyabrya str.
325000 Kherson, Ukraine

Keywords: computer algebra system, education, trygonometry, simplifications, identities, equations, APS.

INTRODUCTION

This message deals with the main aspects of designing computer algebra system AIST, applied for teaching at school a course of algebra. The main purpose of the system is computer support in a process of solving algebraic problems using algebraic transformations.

The version of the system to be realized supports algebraic and trigonometric problems on simplifications, proofs of identities and solutions of equations. (Further on the term "algebraic problem" is used namely for this type of problems).

It is treated by the author as an experimental model of a general CAS that supports a wide class of school-type mathematical problems (logarithms and exponents, differentiation, integration, theory of limits, simultaneous equations and unequalities, geometry, e.t.s)

A special role plays the programming system used for realization of the kernel procedures of AIST. Programming in wide-spread procedural languages generates practically unsurmountable technical difficulties for acceptable time. We are using the algebraic programming system APS [1].

BRIEF DESCRIPTION OF THE SYSTEM

The mathematical activity of a student consists in recognizing properties of mathematical objects and its transformations according to the rules, strictly defined in a corresponding mathematical theory.

Thus the solution process of an algebraic problem is a sequence of steps at each of which some transformation of cur rent expression is made. The sequence starts with a setting a task of a problem and terminates with its solution.

Computer support of the solution process by AIST at each step consists in a verifying of a transformation made by a student (SHORT-STEP mode) or in automatic executing of a transformation according to the students instruction (LONG-STEP mode).

CAS AIST contains the subsystem EXPERT aimed at automatic checking of identities, solving of equations and some other problems.

Like other pedagogical computer systems, AIST provides the user with such means as mathematical REFERENCE BOOK, CALCULATOR, function GRAPHIC manipulating system.

Windows shell COPYBOOK is designed as a computer model of a student's copybook in which a student can solve a current problem, save and look through the solving of the previous problems.

The natural notation form of algebraic expressions in a school-type syntax is provided with specialized formula editor.

CAS AIST is designed as a message-drive system under WINDOWS and MS-DOS. Languages of realization - C++, APLAN (APS high level language).

The author thanks prof. A.A.Letichevsky and S.V.Konozenko for a amiably given possibility to use APS-system and fruitfull cooperation.

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GENERATING EQUATIONS WITH RESPECT TO UNKNOWN SET

L. MURZINA & I. SHEVCHENKO

Department of Informatics, Far-Eastern State University
8 Sukhanova St, Vladivostok, Russia, 690600
E-mail: root@math.dvgu.marine.su

Keywords: problem generator, problem solver, intelligent tool for teacher, set theory.

To assist a teacher in the fields with poor problem support, problem generating systems may be designed and implemented. Usually, problem generators regarded in the frame of ITS [1]. We believe that ideas and achievements of AI may influence learning and teaching processes more effectively through more elementary systems than ITS. Among those systems are problem generators (see, e.g., [2]). We examine an approach to problem generating using systems of equations with respect to unknown set as an example.

Introductory course of Discrete Mathematics for students in Computer Science includes the naive set theory (see, e.g., [3]) as a part. Mastering of this course includes not merely acquiring basic concepts but developing and refining skills in logic reasoning and symbolic manipulation as well. The only way of doing that lies through problem solving activity.

Although the naive set theory relatively well-developed area, very few sources with collected problems are available. Even the best of them contain very few types of problems and very few numbers of the same type problems (see, e.g., [4]). The situation is quite different compared with Calculus where wide range and sufficient quantity of problems within easy reach.

We consider a system $f_i(A_1,A_2,...,A_n,X)=g_i(A_1,A_2,...,A_n,X)$, $(*)i=1,2,...,m$, $m=1$, where $A_1,A_2,...,A_n$ are given sets, X is unknown set, fi and gi are given formulae in the set theory language, '=' denotes the equality of two sets. Solution process of (*) includes four stages (see, e.g., [4]).

1). Transformation of (*) into equations with the empty set as right- hand parts.

2). Transformation of each equation of the obtained system into the form corresponding to disjunctive normal form.

3). Transformation of the anew obtained system into the system of two equations with respect to X and $-X$.

4). Extraction of existence conditions and solutions (if any).

First we implement in Prolog a solver of (*). This solver is represented as a set of rewrite rules (see, e.g., [5-6]). The most of the rules is bidirectional. The level of granularity of the solver is chosen to fit student's solving process. The interpretation process of the rule application is traced. The existence condition and the sequence of the rules determine a problem type.

We treat problem generating as reverse task to problem solving. Starting with a given answer and a reversed sequence of the rules, we apply the rules in the backward direction and come to with the setup of the system.

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TUTORIAL SYSTEM WITH FUZZY LOGIC FOR DATA ANALYSIS

NATALIA A. NASARENKO, VLADIMIR I. GRITSENKO

Glushkov Institute for Cybernetics
Ukrainian Academy of Sciences
40, Prospect Akademika Glushkova, 252207 Kiev, Ukraine.

Key words: tutorial system, expert system, fuzzy logic, data analysis, data processing.

It is very important for students of different specialities such as mathematicians, physicists, chemists, economists to be able to analyze data. There are many statistical methods of data processing, but using of concrete methods depends on data type.In the classical theory of mathematical statistics, for example,it is very important fulfillment of rather strict conditions (such as statistic homogeneous data), which very often are impossible in condition of real experiment.

As a rule, students study courses on classical theory of mathematical statistics, robust statistics, special courses (adaptive procedures, resistant procedures), but, however, there are many problems when they began analyze concrete data. The goal of our tutorial system is to show to students in compare, how work different statistical methods. In that time student is absolutely free from complicated calculations, which very often lead to result that student lost interest to the gist of the task and have no ability to learn data analysis. As a result of study student have to know, that:

It is necessary to use wide and flexible models, which allow to take in account qualities of real input data and there vague.

Method of problem solving must to be high effective and at the same time be robust in connection with input data.

The method must be not very complicate and to correspond to the real ability of researcher and level of model exactitude. Not always precise method give precise result.

The formal side of problem solving must to obey the content of problem and the common sense.

It is necessary to understand the content of results which were turned out.

All that are illustrated on examples and commentaries to them and are represented in fascinating form, to attract interest of student.

The elaboration tutorial system uses fuzzy logic both in stage of creation learning scenario and in the core of task solving. We proposed new fuzzy method of data processing, which with stability data works like the classical method and with fuzzy or incomplete data this method is only possible ones for data processing.

The proposed system is open and teacher, if ones wish may to add new examples, which successfully describe field of science which student is interested in and reflect specific of his speciality.

The data base is also open and may be supplement with new data, which may be remove if teacher want.

The tutorial system under consideration proposed modern and more high level of study data processing , what may be achieve only by using personal computers and owing to high level of service programs.

A COMPUTER-AIDED SYSTEM FOR ENGINEERING DRAWING TEACHING ("KSIINGR")

VALERI B. OREKHOV
Bashkirian Regional Center of New Information Technologies
14, Pereulok Parkhomenko, Apt. #10, Ufa, Russia
E-mail: root@uaicnit.bashkiria.su

The suggested computer system is based on specially developed software of a graphic dialogue. This software is based on "Contour" graphic editor providing carrying out such operations that are normally performed with a pencil, a ruler and a pair of compasses.

The "Contour" provides a screen menu and informs the user of what should be done in each particular situation. It takes no more then half an hour to get acquainted with the system. A set of functions makes it possible to design complicated technical contours consisting of series of conjugating lines, and also to interpolate discretely dotted contours. The interpolation methods used are: circle arcs, second order curves and splines.

While the geometrical element being displayed, recording of its determining parameters into a special array is made. This provides further editing and recording of graphic information.

The above mentioned system consists of 2 parts: teaching and testing. The stage formation of graphic drawing or the principle of dynamics in giving a sequence of operations in solving geometrical problems are applied in the teaching part. The process of explaining is accompanied by a brief commentary and the "twinkling" of the displayed element for each particular operation. The testing part is based not on a multiple choice system but on checking the correctness of the algorithms. This can be done by comparing the result with the standard solution. The probability of the correct "guess" in this case is very small.

The proposed system covers three component parts of engineering drawing: geometric drawing, projective drawing and descriptive geometry.

The suggested software represents for its users an efficient instrument for developing systems to study other technical disciplines. The range of such disciplines are determined by the graphical interpretation of notions studied.

PECULIARITIES OF AUTOMATED EDUCATION AND CONTROL SYSTEMS APPLIED IN TRAINING OF AVIATION SPECIALISTS AT THE INSTITUTE

O. PLATONENKO, L. ZHURAVLYOVA
Institute of Civil Aviation Engeneers (KICAE), Computer Center
1, Kosmonavta Komarova ave., Kiev, Ukraine

Keywords: expert, automated system, aviation-transport system, operator, control, testing, generated characteristic.

Aviation-transport system (ATS) has a very complicated multi-ergatic structure, and every subsystem of the one contains a human-operator. As a result, the effectiveness of ATS functioning depends to a some extent on the functional effectiveness and interaction of its subsystems, and a human operator, in particular.

The effectiveness of the human-operator functioning, as a link of ergatic system, may be determined by such indexes as the level of the professional training, personal abilities, the professional experience and others.

The existing system of aviation specialists training can conditionally subdivided into three stages:

- Theoretical training.
- Practical classes.
- Interaction with real objects.

There is a lot of means, which should be used at the second and third stages, and which allow to bring nearer the tuition to the activity under real conditions. Relatively to the training of aviation specialists, such means are: aircraft simulators, computer simulators, training flights, etc.

As to the first stage, there is a real problem - the shortage of training means, which allow to activate the process of teaching of the specialist and to bring nearer the conditions of the theoretical training to the conditions of the real professional activity. This shortage can overcome removed by using the automated expert-educational and control systems, which can:

- To store and process knowledge.
- To get, to store and use the additional information of specialized subsystems.
- To demonstrate the activity of expert-specialist or the process of his decision making.

Such systems in each case are oriented to the training of peculiar specialists, so this orientation depends on the stored information (knowledge). In these circumstances the synthesis of the structure of the mentioned systems requires realization of the common principle of the data-operated systems.

There are some significant demands to the teaching process, which includes the automated training and control. One of them is to put and realize corresponding pedagogical problems in the automated system environment and to organize the reverse connection. The term "reverse connection" means the process of forming the tuition procedure, which contains the operated influence.

The process of organizing of the tuition procedure inside of automated system environment can conditionally separated into some stages:

- Forming of generalized characteristic of the expert-specialist. The totality of parameters of generalized characteristic determines some top meaning of the training level, which corresponds to the necessary professional demands.
- Determining of the trained human characteristics, who is functioning as a human link inside the contour "human-equipment-conditions". The totality of parameters, which characterize the abilities of human-operator, should determine the structure of tutorial dialogue : duration of the time of teaching, the volume of information, the frequency of repetitions, the necessity of prompts, the time of answer and so on.
- Of information presented. The structure of the course, correlations between different courses and other characteristics of information presented are determined at this stage. The structure of tutorial data base is configurating according to the structure of the courses and with taking into consideration the developed scale of appraisals.
- The filling of the system.
- Maintenance.

The main items are realized in the process of training students at Kiev Institute of Civil Aviation Engineers .

So, as it is known, KIIGA carries out the training of flight engineers, pilots of air crafts and helicopters. In connection with this the automated expert-information system (AEIS) for tutorial purposes and examination of students has been elaborated at Pilot training department of the Institute. This system is developed for using on the stage of before-flight-simulator training for the courses : " Flight Operations Manual of Tu-154Б", "Safety of flight" - the topics "Aviation meteorology", "Flight navigation", "Preparing the Documents of Flight Incidents Investigation".

The AEIS has been elaborated on the base of the main concepts, which are used now during the process of creating of the intellectual systems. The structure of AEIS includes the model of expert-specialist, the model of educated person, the means f storage and application of knowledge, data base, the means of testing.

The theoretical stage of training needs the effective means of illustrating materials on the professional activity of specialist, physical processes, which have place in every flight situation, the results of mistakes etc. So, the system "UROK" fits for this case, because it includes the means, which allow to demonstrate each process in as a computer game.

As for computer control and examination - the automated system "ADONIS" is used in this case. The periodical control and examinations are made by means of this system. As an example, the automated control of the courses of ground maintenance of aircraft, theoretical mechanics, chemistry is effectively used.

The computer center of KICAE includes the group, of researches, which deals with modern information technologies and has some author elaborations. The existing concepts of testing and automated control are at the base of these elaborations. The main items of these researches

connected with famous works of R.Atkinson, G.Bower, R.Bush, F.Mosteller, A.Sviridov, G.Shibanov and others, and includes the providing of the main pedagogical problems, such as

- Identification of ideas.
- Adoption of logical systems.
- Learning of twin associations.
- Adoption of decisions.
- Discovering of signals, etc.

One of elaborations has been done on the software of system ADONIS and connected with including modernized data base of education testing results, which allows to get the extended information about the results of each action of testing, to measure the validity of test, correlation links among different courses and etc.

These elaborations have been done with assistance of Kiev Institute of Design.

The results of experimental application of these systems show the increasing of the training level average by 20 %.

COMPUTER TEXTBOOK ON THE MONTE-CARLO METHODS

VLADIMIR N. STARIKOV, MARINA S. MAKHMUTOVA,
SHAMIL A. MAKHMUTOV
Ufa State Aviation Technical University
Ufa, Bashkiria, Russia
E-mail: makhm@uaicnit.bashkiria.su

Keywords: simulation of random variables, Monte-Carlo Methods

Active introduction of computers in education allows to use new computer technologies in training, requires developments of methodical software for any branches of science and, in particular, development of computer textbooks.

Computer textbooks can be an aid in lectures and in practice and also be used for independent study. Graphic and dynamic illustrations help to show vividly the procedures of solving problems.

Educational research " System for statistical simulation Monte-Carlo Tutor (MCTutor)" is designed for independent study of some parts of the course "Statistical Simulation" and solution of applied problems by the Monte-Carlo Methods.

Generally speaking, system MCTutor is computer textbook and consist of two parts:

- Simulation of random variables.
- Solution of applied problems by the Monte-Carlo Methods.

Educational component of System gives a possibility to study:

- Random variables and their distribution functions.
- Methods of simulation of random variables by given laws.
- Main principles of the Monte-Carlo Methods.
- Solution of applied problems by the Monte-Carlo Methods.

Research component of System gives a possibility:

- To simulate random variables by given discrete or continuous law using different methods.
- To calculate definite integrals.
- To solve the boundary value problems for elliptical equations using random walk by spheres and random walk by networks.
- To simulate tracks of fractions inhomogeneous and in inhomogeneous mediums and to solve integral equations of transfer.

This System was developed for IBM PC by aids of programming support environment ADONIS and the programming language Turbo-Pascal, version 6.0.

ELECTRONIC-WORKBENCH AS INTEGRAL PART OF BASIC CIRCUITS AND ELECTRONIC COURSES

JASIM M. THIAB & IVAN PANKOV
Computer Education Lab
Technical University, Sofia, Bulgaria

Introduction

Circuit analysis programs are playing significant role in computer-aided design of electrical and electronic circuit. Different types of analyses are available to determine ciruit performance. Different types of programs are available for the simulation, analysis and design of electronic circuits such as MICRO_CAP and PSPICE and PSPICE.

The application of Electronic-Work Bench (EWB) which we describe below have at least several worthwhile objectives. One advantage in the use of EWB is that student can experiment with digital and analog electronic circuits and perform different types of analysis without using scarce and expensive laboratory facilities and materials. The test instrument in EWB have the basic controls found on laboratory models and must set up in the same way.

Feature of EWB

EWB allows the user to :

- Draw electric circuits on a video monitor
- Simulate the activity of that circuit.
- Display its activity on test instruments contained within the program.
- Print a copy of the circuit,the instrument readings and parts list.

EWB has seperate modules for analog and digital logic circuits. It was designed to be so easy to use that it takes almost no time a way from learning the subject. EWB provides an ideal environment for learning theory of analog or dititat electronic circuits, fundemental theories and applications of electricity, electronic devices and the principles of digital circuits. EWB needs a mouse for work.The screen contain test instrument, program control, part bin and work space, the test instrument include the following :function generator, oscilloscope, battery, word generator, logic analyzer, multimeter, Truth table, Bode plotter.

Integration of EWB into Special Training Course

A special training course is held for a selected no of students from different departments which are in the last year. They thaught different programming tools which are used for educational

purposes. The main tool was EWB. Different examples covering different subjects such as network theory, fundemental of electrical Eng, principle of digital circuits. EWB was introduced in these subjects because

- The students have some background in these subject and they can appricate EWB as a tool for analog and digital computer simulation
- The students are highly encouged to learn new tool when they use it in different disciplines after graduation.

EWB Assignments

EWB can be used primarily in teaching the following fundemental area of AC/DC circuit analysis and electronic devices.

Analog Modules:

- Ohms law.
- Component in series, parallel, mixed circuits.
- Kirchhof's current and voltage laws.
- The function generator, oscilloscopr and bode plotter.
- Resonants circuits.
- Rectifying circuits.
- Amplifiers.
- Operational amplifiers.
- Stability of DC operating point.
- Properties of the common-emitter amplifier.
- Wien bridge oscillator.
- Transformers.

Digital modules:

- Basic components and logical functions.
- The word generator and the logic analyzer.
- Complex digital functions.
- Logic elements.

Different examples were given through the course covering most of the above topics. These examples provide an introduction to some of the capabilities of the EWB, and to explore the verious features of the schematic drawing software, analog and digital of EWB.Students were asked in the begining to draw circuits and how to use test instruments in their work.

Limitation of the EWB

There is no software package which is compeletely perfect. EWB has some limitation, these are:

- New elements can not be drawn and added to the part bin.
- It is not possible any more to show labels and values at the same time.
- Variable resistors and variable DC power supplies are not modelled in EWB.

- The MOSFET and the Junction FET are not modelled in EWB.
- There are no current or voltage -controlled sources available in EWB.
- It is not possible to store the scope and bod plotter images, so long simulations do not have to be run again when reloadings a circuit. Furthermore it would be nice when the graphs of these instruments could be enlarged to fill the whole screen with proper axes.

Conclusion

One advantage in the use of EWB is that student can experiment with digital and analog electronic circuit and perform different types of analyses without using scare and expensive laboratory facilities and material. This laboratory experiment will reinforce the theoretical presentation of the lecture.It gives the students confidence in engineering practice. EWB is powerful enough to let students to do most assignments and exercises in electric circuit and electronic. It also provide an ideal environment for learning the basic theory of analog and digital circuits, and is recommended for use at any level of an electronics curriculum. We beleive that application of such system EWB is worthwhile and productive and will have at least several worthwhile objectives in basic educational purposes and for vocational training.

APPLICATION OF THE INTELLIGENT SYSTEM EXAPRAS FOR EDUCATION

A. YANKOVSKAYA , A. GEDIKE
Intelligent System Laboratory
Tomsk Civil Engineering Institute
2, Solyanaya Square, Tomsk, 634003, Russia
E-mail: post@kisa1.tomsk.su

Keywords: intelligent system, decision-making, recognition of patterns, logical combinatorial transformations, cognitive graphics.

The EXAPRAS system [1] is based on the possibility to solve problems of decision-making by the logical combinatorial methods of a pattern recognition with tutorial sample (training).

A non-traditional matrix model of knowledge representation as well as variable space minimization (optimization) algorithms, of solving rules construction and decision making based on binary (ternary) large dimension matrix equivalent and optimizing transformations [2,3] had been developed within the approach indicated.

Relational type knowledge base arranged on the module principle is being used in EXAPRAS system for knowledge store and operative access to it. A separate module knowledge base concept is being linked with every tutorial sample.

In order to solve recognition problems according to knowledge base chosen module description *(Q)* and distinguishing *(R)* matrices are constructed.

Matrix Q rows are juxtaposed with the objects from tutorial sample, columns are matched with variables characterizing each object. Matrix *Q* element gives variable value for corresponding object.

Matrix R rows are matched with the same name of matrix *Q* rows; the columns are matched with variables which define distinguishing levels, i.e. various mechanism of objects partitioning into equivalence classes (classification mechanisms). Matrix *R* element assigns object belonging to one of the selected classes at corresponding classification mechanism.

As for substantiality matrix *R* may be one of the following three types. The first type is characterized by involving mechanism of classification, the second type serves for representing

independent mechanisms of classification and the third type may be interpreted as the sequence of actions which are to be done for a given object (in a given situation).

It is considered, that object descriptions of tutorial sample, not obviously contain the information about regularities allowing to distinguish the objects relating to various patterns. Revealing regularities above mentioned enables to select informative variable subsets, that is to carry out variable space minimization (optimization).

Under the tutorial sample representativeness, the regularities revealed allow to construct effective logical deduction schemes (solving rules) capable of recognizing correctly the objects under test *(OUT)* shown with the accuracy required.

For argument of decision-making we use four original methods of graphical visualization with cognitive graphics elements: special bar chart and circular diagram with segment (rectangle), regular n -simplex, Karnaugh map.

The bar chart reflects relationship among numerical values of conditional nearness degree of a *OUT* to all the separated patterns.

The circular diagram with segment (rectangle) reflects relationship among numerical values of conditional nearness degree of a *OUT* to all the separated patterns as well as the locations of the object in relation to two (four) patterns.

An equilateral triangle (regular 2-simplexes) allows adequately to display the *OUT* spatial location for the objects from three characteristic patterns.

The initial matrix method on the basis of Karnaugh maps permits to display the *OUT* spatial location for the objects from each pattern. Heuristic algorithms of such ordering of variables at which showing patterns becomes more compact are suggested by us.

EXAPRAS system program components are realized in C-language with IBM PC/AT and MS DOS orientation and consists of a dialogue monitor and three subsystems: knowledge base control, knowledge base optimization, decision-making.

The EXAPRAS system (after the disaster medicine knowledge filling) was used for learning to correct making out of diagnostics, sorting and organize-managing decisions. At learning the high efficacy was achieved because of used of convenient knowledge representation way and different cognitive tools of decision-making results argument.

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TUTORS MODES AND SOFTWARE SUPPORT IN EXPERIMENTAL DATA PROCESSING SYSTEMS UP TO INVERSE PROBLEMS OF IDENTIFICATION.

P.N. ZAIKIN, T.B. PODOSENOVA, T.V. KIRISOVA
CM&C Department of Moscow State University,
Leninskije Gory, 119899 Moscow, Russia
E-mail: PNZ@.cs.msu.su

Wide spreading of personal computers in science and advanced industrial technologies has lead to more comfortable service and calculations and to their intellectualization by using of complete models, more precise numerical methods and intellectual systems of solution of inverse problems of interpretation of data. As a consequence of this process the problem area is changing due to new models, simulation tools and computer technologies. The new approaches are necessary to learn users to use these computer systems.

In this report we discuss our approach to the procedure of introducing into informational and computer images of the problem studied and into using of corresponding applied software.

Our software collection consists of several kinds of packages. The first kind is intended to solve problems in such domains as physics, biology, chemistry, technology etc. The second kind of packages consists of programs that are intended to solve typical mathematical problems arising from data processing.

In particular, spectrometrical software realizes the following stages of data treatment:

- Simulation of quasi-experimental data, phenomenons models, weight function of detectors, noise etc.
- Preliminary data treatment and analysis of data.
- Calculation of calibrate functions, registration efficiency etc.
- Fitting of weight function of detectors, identification of elements and calculation of their amounts.
- Estimation of quality of fitting by using of different criteria.

Tutor mode of packages includes practically all aspects of multimedia systems: show-screen professional pictures to introduce in the problem area (as animation of informational and computer images of the problem studied), dialogue-graphics regime to train users by exercises and tests. We suppose to use the psychological testing to create the individual student's image (model) to set up the friendly interface of our computer systems.

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A KNOWLEDGE-BASED SOFTWARE ENVIRONMENT FOR TEACHING AND LEARNING

IRINA ZHELIAZKOVA
Department of Computer Science
Technical University of Rousse
8a, Studentska street, 7017 Rousse, BULGARIA
E-mail: JEP2614@VARNA.BULPAC.BG

Keywords: learning, teaching, conceptional block model, functional requirements, global system, local systems, environment architecture, technological schemes.

The method "learning by making models" is known to ensure knowledge acquisition on the level of understanding and application. On one hand the student has a free end flexible access to the knowledge model of the expert-teacher, and on the other hand he has a possibility to construct this model. The application of this approach for the wide practical usage requires a development and evaluation of different software environments. They create facilities for the teacher in the preparation of the teaching material and in the planning of teaching process, for the student in performance of intellectual activities, for the administrator in the group organization and management of the teaching process.

In this paper we discuss a conceptional block model of the teaching process in a large subject domain, based on the method "learning by making models" and on the common theory of systems. It differs from the other known to us models with: a tree decomposition of the subject domain structure with terminal local knowledge bases in the form of "fill in" frames, classification trees, systems of rules, etc.; a tree decomposition of the global teaching goal with the following parameters: capacity of knowledge, time of acquisition, coefficient of acquisition, coefficient of environment confidence; individual approach to the teaching and learning; data accumulation for making decisions concerning subject domain structure, teaching plan, teaching material and student learning.

The idea of using object-oriented approach to the preparation, presentation and evaluation of the student performance for the local knowledge is demonstrated on the example of the classification type of knowledge.

The functional requirements to the knowledge-based software environment for teaching and learning concerning the whole environment, subject domain teaching strategy, student performance and user interface are formulated on the base of the proposed global and local models.

One possible architecture decision of such an environment is presented. The global system, using all local knowledge bases and a global base, consists of the following program modules: subject domain structure editor, teaching planner, plan executor, student performance analyzer, student current state documentator, student history documentator. The local systems, using only the corresponding knowledge base, have the following typical structure: formal knowledge editor, informal knowledge generator, teaching strategy interpreter, file stack manipulator, informal knowledge documentator. Administrative system, using only global base, includes: dialog manager, knowledge base scheme generator, user registrator, multi-language communication dictionary editor, file manager, user documentator.

Finally the technological schemes for the different user categories (teacher, student and administrator), and for the different modes (preparation and planning, teaching and learning, administrative service) are given in the paper.

The software product, implementing the above described conception about the knowledge based software environment for teaching and learning, is registered in the Bulgarian National Software Project Fund under No 1.034.01820-01.

COMPUTER -BASED TUTORING SYSTEM FOR LEARNING LITHUANIAN LANGUAGE

KAZYS BANIULIS(*), BRONIUS TAMULYNAS(**), DAIVA DMUCHOVSKA(***), JOLANTA NORMANTIENE(****)

(*) Kaunas University of Technology (KTU), Computer Software Dpt., Rokishkio 7-1, 3005 Kaunas, Lithuania

(**) KTU, Computer Software Dpt. Ukmerges 10-52, 3043 Kaunas, Lithuania

E-mail: bronius.tamulynas@if.ktu.lt

(***) KTU, Lithuanian Language Dpt., Sukileliu 102-41, 3043 Kaunas, Lithuania

(****) KTU, Lithuanian Language Dpt., Grichupio 7-225, 3031 Kaunas, Lithuania

Keywords: learning system, knowledge-based learning process control, vocabulary.

The purpose of this work is to build up Computer Based Lithuanian Language Learning System which will satisfy needs of various users (school-children, students, etc.). The Computer Based Lithuanian Language Learning System is considered a part of the general Intelligent Tutoring System (ITS), which include the following modules: subject oriented tutoring modules, subject oriented data base modules (vocabularies, tables, specific subject information), tasks and lessons making data base modules, and students modules.

ITS is an object-oriented system and so it is open for new courses, tasks, lessons and ultimately for new linguistic subjects. Each module of ITS contains a number of objects which communicate with and are defined by a hierarchy of other objects.

The aim of this report is to discuss the ways of knowledge representation and learning of the Lithuanian language which are used in this system. This goal is attained by: 1) building up the vocabulary; 2) filling in the vocabulary; 3) making lessons; 4) learning process control.

- BUILDING UP THE VOCABULARY. The main goal of the computerized vocabulary is to accumulate and supply systematized and classified information about words and their constituent parts. This information is necessary for study and scientific purposes. Commonly, a word can have more than one constituent part of the same type. On the other hand, the same constituent part can be a member of a great variety of words. Therefore, to avoid redundancy we have used a relational form of the vocabulary.

- FILLING IN THE VOCABULARY. Within the limits of the School Orthographic Dictionary of Lithuanian (about 16000 words), classification, structurization and characterization of information presented in the dictionary was made. Classification means assigning each word to one of the parts of the language (e.g. noun, adjective, verb, etc.). Structurization means singling out syllables and parts of a word and indication of stress. Characterization is connected with indication of certain attributes and additional information, and is performed for each of the parts of the language according to a separate pattern.

- MAKING LESSONS. The Lithuanian language model implemented in the vocabulary base allows to perform syntactical and morphological analysis of student answer. The tutor designs lessons using vocabulary and task bases, forms his own teaching strategies preparing compound lessons. The teacher can use an ability to add new subject knowledge into the data bases if necessary. Traditional exercises, game situations and dynamic models are being employed for the lessons modules, using various techniques: to answer, fill in the gaps, compose the answer from separate elements. In the gameplay approach traditional tasks are supplemented with visual illustrations (a train, stairs, a balloon etc.). Dynamic models make the original graphic illustration of the verbal text.

- KNOWLEDGE BASED LEARNING PROCESS CONTROL. The ideal behaviour of an ITS system for knowledge based learning process control is required to be similar with that of human tutor. This purpose is achieved by making references to a human tutor's desired characteristics and simulating natural learning process. ITS consists of the four

types of knowledge based modules. They are the problem-solving expertise, the student model, the tutoring strategies and the model of natural interaction process student-computer.

The problem-solving expertise is the knowledge that the ITS tries to impart to the student. ITS give tasks to the student and evaluate the correctness of the student's solutions. The main part of this module and most of its functions are implemented in authors tools to design lessons. Evaluation results of the student learning are kept in student's data base and may be used for farther structurization and control his knowledges on subject matter if needed.

The student model represents the student's understanding of the material to be taught. Its purpose is to make hypotheses about misconceptions, optimal performance strategies, indicate why they are wrong and suggest corrections. SM also contain information about the student's prefered modes for interacting with system, characteristics of the student's level of ability, a consideration of what knowledge may be forgot over time and how it may be renewed. The main point of this modul is students data base which include all mentionned features and characteristics of students (names, data, identification number of tasks, evaluation, personal ability etc.).

The tutoring strategies specify how the system presents material to the student. The module integrate knowledge about teaching methods, the student model and the subject area. This is the modul that communicate with the student, selecting problems and tasks to be solved, knowing how to teach. The main source for this module is subject area structured knowledges (semantic network).

The natural interface provides the user with the facility of communication with ITS. It is a meta-level knowledge for communication with other modules of the system.

All these ITS's modules as well as another constituent parts and data bases in the system are implemented in C++ object-oriented manner. So, they are closely interconnected with each another and have possibility for corrections and additions. Currently the ITS for learning Lithuanian language is on going research under testing and verification presented modules and data bases.

INTELLECTUAL MULTI-MEDIA FOR THE HUMANITIES LEARNING AT TECHNICAL HIGH SCHOOL

SERGEY V. BOBYREV, OLGA N. DOLININA
Saratov State Technical University, Saratov, Russia

Keywords: humanities, historic cuts, multi-media, frames, production, tutorial model, interaction of cultures.

When teaching the humanities at technical high school, colleges there appear some difficulties, connected with the lack of basic knowledge in the field of culture on the part of the student. Besides that, if the student's level of technical subjects knowledge is relatively the same, then the humanities knowledge level spread is very high.

That's why there appear the task of developing the medium facility, program which provides an opportunity, within short time and on the whole independently, to learn both the basic facts of the world culture and the processes of interaction between different cultures in geographic and temporal aspects (depending of time).

The facility must provide full and visual representation of the information and have possibilities of adaptation to an individual student.

These requirements can be fulfilled by tutorial systems based on intellectual multi-media, developed by the authors.

The learning of the cycle is based on consistent examination of "historical cut", when each "historical cut" considers correlation of conditional composite parts, which reflect current state of culture. Conditional composite parts are, for example, States and Wars; Ethnos, Language and

Writing; Religion; Art; Science; Technique; Technology; Communications (trade ways, geographic discoveries, post).

This way, student studies the development of the the planetary culture as the whole at each historical stage.

Game is the basis of the tutorial method. It provides full realization of the idea of intellectual personal contact with the tutorial system. The block of games, which includes game situations: "Time Automobile","The Old Curiosity Shop","Hunting in Time","Lost in the Past","Star's Voyager" through dialogue,persistently values the knowledge of the student and after comparing the present knowledge of the student with the model student's one, makes a decision on choice of tutorial strategy. Student can look at the results of the analysis of his personality and also at the system's chain reasoning.

As is known images are best assimilated by a human being. That's why the information in the system on the whole is formed by graphic pictures. For example, the main type of computering images is - "supermap", which combines the geographic zone image and thematic picturegramms.

In order to achieve complex system approach to teaching, all information is formed on the basis of multi-media and includes audio-visual materials and illustrative material in the form of slides. To provide the student's independent tutorial work, (this type of teaching we consider to be one of the most effective) the system has context-sensitive, hierarchical and hypertext help.

The knowledge base was developed by encyclopedic sources as well as expert-knowledges of humanities teachers, specialists in the field of world culture.

For knowledge representation there was chosen combination of frames and productions. There are used the following frames: personality, state (country), a piece of art, scientific result, geographic zone, historic period and so on. As usual frame includes the following slots: images, text message, attribute - string, attribute - numeric, attribute with it's own structure, classified character.

With the help of productions there are developed interactions between frames. For example, interaction between states - wars, amalgamations, separation, interactions between regions - trade ways, interactions between types of world cultures - attribute's transmit.

This knowledge representation permits to organize 4 main approaches in forming the subject of teaching:

- Temporal: there are examined synchronical and diachronical historic cuts of culture. Main attention is given to consideration of the process of development of the whole planetary culture; to revealing the general dynamics and dialects of development;
- Structured: there is examined the development of each composite part of culture. Main attention is paid to the interaction of composite parts and to the role of each composite part in the whole culture;
- Problem: there are examined complex problems, which are solved by interaction of all composite parts of culture. Different approaches are compared;
- Regional: there is examined the development of region's culture. Main attention is paid to the influence of local conditions on the peculiarity of culture and to the interaction of different cultures, for example, "West - East", "Russia - India".

During the realization of these approaches there is formed in the system the set of correlated goals, which are achieved in tutoring process. And the use of the "friendly" explanation block gives additional tutorial effect. This block is being used to objectively mark in student's knowledge, which allows the student to define & locate the "gaps", "lacunas" in his knowledge and simulates him in his further studies.

All approaches are realized by mechanisms of direct and reverse inference. For inference control metaproductions are used.

Tutorial goal is to form the student's ability, firstly, to define the set of attributes in accordance with the property (where property is the concrete historical period), secondly, to pick out attributes of the set from input information and, thirdly, to realize the inference procedure.

RUSSIAN & UKRAINIAN LANGUAGE COMPUTER COURSES FOR BEGINNERS

N. CHEMERIS, T. KOVAL
Kiev Pedagogical Institute of Foreign Languages
,73, Krasnoarmeyskaya, 252150 Kiev, Ukraine

The Information Technology & CALL Lab of the Kiev State Pedagogical Institute of Foreign Languages has much experience in creation and usage of CALL courses in foreign languages learning, Ukrainian and Russian as a foreign languages in particular.

Designing CALL courses we use different types of scenario depending on the users' age, aim and the level of language competence.

Our AUTHOR-system allows to build CALL-courses according to module principles. Their main components are: 1) new material presentation, 2) text material exercises, 3) dialogue exercises, 4) language games, 5) language tests.

The new material presentation may include semantic, grammar, verbal and other language aspects. It is possible to perform it at the beginning of the portion, introducing the new material, as a response to the user's request ("HELP") or as a reaction to a wrong user's answer.

The text exercises may be classified according to the presence or absence of all the necessary reference material and the actions the user has to perform (to point the necessary element with the cursor, to input its number or to print the proper element). We use exercises where the user should fill in the blanks in the words or sentences, to order elements in the sentence (words) or in the text (sentences), to change grammar or syntactic form (transformation), to translate from a foreign language into the native one or on the contrary. In the text of the supplement exercises the teacher marks the elements to learn. When doing an exercise the user may observe all the multitude of the omitted elements and has to select the correct response from the offered "menu". More difficult variant of this exercise is one in which the user has to fill in the text blanks without any menu. You can use so-called Storyboard as an example of the text reconstruction without menu support. The essence of it consists in restoring of the text, presented on the screen as a title and dashes instead of characters; blanks and punctuation marks are preserved. These exercises are efficacious when learning vocabulary and spelling.

The dialogue mode exercises comply with the intensive methods of foreign languages learning assuming constant speech intercourse among students (in our case - between a user and the computer). Most often such intercourse consists of microdialogues in the form of "question" - "answer" - "retort". Using the computer as one of the interlocutors we have obtained an efficacious means of improving user's speech experience. The main problem when supplying these exercises is the step of the control of the answer correctness.

Language computer games are divided into two classes - training and control. Training games consist of numerous repetitions of similar actions. When using training games a user is assumed to answer the computer questions with pressing of one or more keys or printing the text. Control games are destined for estimating user's knowledge in some foreign language features. Their distinctive characteristics are dynamics and competitions. When working out the authoring games we use all the computer possibilities such as graphic, arts, colors, music accompaniment to make them attractive.

Language tests are one of the computer control means.

When preparing the test material the author has to define the form of each task and depending on it its view on the computer screen and the way of users' answer as well as checking it up with the computer. Taking them into consideration we delimit 5 task's form such as : 1) directive, 2) alternative, 3) multiple choice, 4) cross selection, 5) constructed answers.

Relying on the described above AUTHOR-system possibilities when working out the CALL courses we follow the following principles:

- The themes of the consistent portions have to be complied with the themes of the main manual.
- Each computer portion can be used to increase the users' activity when working at school hours as well as their self training.
- One course computer portions are joined with similar principles of new material instructions and training and control exercises (the users' unification principle).
- Individual track for each user is guaranteed by his current results when executing exercises and tests as well as his constant characteristics being stored in the users' data base.
- For the acceleration courses production we use authoring facilities with the help of which the teachers can create their courses (the teachers' unification principle).
- Some courses have the same characters, and this fact makes the artists' and designers' work easier (the designers' unification principle).

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HYPERTEXT TRAINING, INFORMATION AND CONSULTATION SYSTEMS

T. GRINCHENKO, O. CHEMERIS
Institute for Applied Informatics
23-b, Krasnoarmeyskaya St., 252004 Kiev, Ukraine

We propose some training, information and consultation systems based on the hypertext technology. It is friendly not only to the users but also to the authors, when being completed with new facts.

Our first manual, based on it concerns to distributed database systems and transaction processing.

The user can get information thanks to references to each nod. The hypertext technology does not demand any special computer knowledge and allows to look through the information in a nonlinear mode depending on user's design. We use scientific magazines and encyclopedia materials for information base of this manual.

But the users of this manual were tired using it for a long time because of its monotony. And that is why we try to make training process more attractive by using pictures for our next manual. This is hypertext training system "ENGLISH FOR BEGINNERS". Besides illustrations for texts, vocabulary, phonetic and grammar materials it also includes some exercises and allows the user to get various consultation at any moment. The manual includes 30 lessons, and ten of them have pictures. It consists of four parts, 2 Mb in each of them.

The third system we want to show is the hypertext information and consultation system "KIEV LANDMARKS DESTROYED IN THE XX-TH CENTURY".

The Ukranian nation has been excommunicated from its historical past for long decades. During this time thousands of historical monuments were demolished, the names of their creators were swept away. The system we propose gives the possibility to pick up systematized knowledge concerning the Kiev historical landmarks lost during the XX-th century, their view, the time and history of their creation, the architectural style, the names of their founders, etc. Many of these monuments belong to the world culture.

Objectives of this work is maintenance and spreading through the computer technology the ancient Slavic Kiev capital landmarks, devastated in the XX century. This work is directed to the humanization of science and education.

The hypertext technology has been applied as the most available one to work up the systems integrating the separate information. The sound accompaniment is available. Preliminary historical, analytical and archives studies were performed to assemble the graphical and text information related to the objects, comprising by the system.

The theoretic basis for the separate multiuser mode has been also projected by the support of the multiusers access to hypertext in the LAN on the basis of transactions control means.

The project results yielded in the methodology of the hypermedia systems creation as well as in 'KIEV LANDMARKS DESTROYED IN THE XX-TH CENTURY, - the applied progressive guidance & training system developing, that allows to:

- Read the article with the all monuments description and get the illustrative image of any of them.
- Choose the necessary object at the city map and to receive a brief historical reference about it.
- Look through the the list of all the monuments with images and the backgrounds in the album mode.
- Use the glossary of the architectural and historical terms.

The importance of the work performed is as follows:

- Instrument to make up the the applied hypertext graphic and text informational systems has been created.
- The system comprises the landmarks of the world's culture level and refers information on the outlook, history, creation and demolition years to every historic fragment included.

The system can be applied in historical museums, museums of architecture, institutions working on the remodeling of the city original architectural landscape; at schools, institutes and tourist agencies, hotels, city magistrates etc. The system might be highly helpful for organizations and private persons who are engaged into the Slavic culture studies. Also it can be used in the system of cultural inheritage of UNESCO. The system is progressive and is being extended to more historical data.

To demonstrate our hypertext training, information and consultation systems, it is necessary to have the IBM PC XT/AT compatible computer of following configuration: RAM 800 Kb; EGA/VGA monitor; "mouse"; FDD 5.25"; HDD.

TEACHING ENGLISH TO RUSSIAN-SPEAKERS BY COMPUTER: AN ISRAELI EXPERIENCE

LAURIN F. LEWIS(*) & GEDALIAHU ZILBERBERG(**)
(*)Department of English as a Foreign Language
Hebrew University, Jerusalem
LEWIS@AGRI.HUJI.AC.IL
(**)Consultant for the Integration of Computers in Education and Remedial Teaching.
gedalia@pluto.cc.huji.ac.il

Keywords: EFL, English, language teaching.

Few teachers of English in Israel have been trained in the technique of teaching their subject without recourse to the mother tongue of the students. Therefore, the arrival from the former Soviet Union of thousands of pupils who do not know Hebrew and have to learn both Hebrew and English simultaneously has created a special challenge for the Israeli English teaching profession.

One response to this challenge has been the development of WORDS IN CONTEXT, a vocabulary learning program, which teaches 3,500 words of English, ranging in level from 7th to 12th grade. This courseware uses Russian translation at several points in the learning procedure. Review of grammar is also provided, with all the explanations in Russian. Training in English pronunciation is added through the use of phonetic transcription. The Israeli Ministry of Education has accorded its approval.

This courseware incorporates texts by famous EFL author L. A. Hill, supported by abundant illustrations. The teaching is thus fully contextualized to maximize absorption of the lexical material.

WORDS IN CONTEXT, which was developed in 1992 by Linguatech company of Rehovot, is now in use in several schools in Israel. A comparative study which is currently in progress will measure English vocabulary acquisition by pre- and post-testing, using frontal teaching as a control. Meanwhile, this courseware has been reported to be having success in relieving the frustration of Russian-speaking pupils, who are trying to learn English in a context in which the language of instruction is also unfamiliar.

In this presentation, WORDS IN CONTEXT will be demonstrated, and its possible applications to the needs of pupils in Russian-speaking countries will be examined.

ADAPTABLE COMPUTERIZED SYSTEM FOR TEACHING THE UKRAINIAN LANGUAGE AND ASSESSING KNOWLEDGE

N.V. RYABOVA, A.Y. YEVSYUKOV, Y. V. LANDGRAF
Kharkov Institute of Radioelectronics
14, Lenin ave., 310726 Kharkov, Ukraine

Keywords: tutoring system, Ukrainian language, linguistic knowledge base, dictionary database, automatical text processing.

This report gives description of the system which is intended for teaching Ukrainian and assessing knowledge on various levels: morphological, word-building and syntactical. The software and informational-linguistic supplying are separated, which makes the system open, adaptable, hierarchical, and module-structured. The system includes the following subsystems: teaching the correct spelling; teaching the correct punctuation; morphology; word-building; lexics and phraseology. The core of the database (DB) used in the system is a set of various dictionaries stored in the memory.

Each subsystem is built as a finite set of lessons, contained grammatical material from studying topics and practical control-training tasks. The system is adapted for the level of user's require-

ments (or level of his knowledge) and suggests three levels of training. Low (first) level corresponds to situation when user almost doesn't know Ukrainian language. In this case the system suggests russian-language interface with automatical dictionary support, allowed to get fast translation for any word marked in the text. Middle (second) level corresponds to the knowledge level of average school-lever and contains theoretical material of Ukrainian language for secondary school, control-training exercises and tasks. High (third) level corresponds to user, which thinks that he knows Ukrainian language perfectly and wishes to check and control own knowledge level or repeat some grammar material.

Modules of first and second tutor levels are intended for schoolboys in the main. So these modules are supplied by computerized fragments of animated cartoons and ukrainian songs. Third tutoring level includes diagrams illustrating the correct using of each rule and giving possibility to observe knowledge level visually. In the tutor-training regime all modules have possibility for dictionary DB call and getting necessary support (translating the word, its grammar characteristics, and so on).

This system includes linguistic knowledge base represented by totality of intercommunicated blocks contained linguistic rules definite levels of language structure and interacted with dictionary DB.

At present the subsystem "Ukrainian Spelling" has been finished, the subsystem "Punctuation" is close to completing.

This system is elaborated in Kharkov Institute of Radioelectronics at the Computing Software chair, and is intended for realization on IBM PC XT/AT compatible computers.

COGNITIVE MODEL OF THE RUSSIAN ORTHOGRAPHY COMPUTER COURSE

VLADIMIR RONGINSKY, SVETLANA DIKAREVA, HELEN ILOWAISKAYA
Simferopol State University, Crimea, Ukraine
E-mail: Dikareva%ssu.crimea.ua@ussr.eu.net

Keywords: computer assisted language learning, cognitive linguistics, knowledge base, Russian orthography.

In paper we suggest a concept paradigm for computer assisted language learning; orthographic Knowledge is considered within the other language Knowledge system (phonetic, lexical, morphological, syntactical), pragmatic knowledge and knowledge about a world; a description is given of structure and interactive strategies of a computer course in Russian orthography (user - computer parity dialogues, ramified exercise system, flexible estimation system).

THEORETIC BASIS. Theoretical problems of Language learning by means of a PC envelopes the analysis of a Language intercourse as a cognitive process; investigation of opinions and purposes of intercourse members; influence of social and ethnic factors on L usage mechanism; the role of stereotypes and personal Knowledge in perception and text engendered. Scrutinized analysis of social and cognitive factors of a Language proves Language intercourse to be a complicated process based on different types of language and nonlanguage Knowledge.

Pertinent to PC simulating Language Knowledge is an interdependent system where the Lower Level Knowledge (orthographic) depends on the higher Level Knowledge (morphological, lexical, syntactical). Imperfect Knowledge or its improper use results in communication failures both between man to man and man to PC .

Orthographic blunders are common for written communication failures. In written form those errors are missed or wrong letters, letter transposition or superfluous letters. During human interaction orthographic mistake distorts the message, and during a man to computer one such mistake makes a word absolutely unrecognized and unidentified, and the meaning is lost.

The Russian orthography rules are guided by the phonetic knowledge (рассказать - разгадать); word mounting structure knowledge (винный -львиный); by the knowledge of prefixes and words' meaning (пребывать - прибывать); by the phraseological knowledge (притча во языцех) by the syntactical knowledge (тушеный заяц - тушенный в сметане заяц). Thus the orthographic knowledge is included into the system of other Language knowledges.

Besides single graphic spellings are connected with nonlanguage knowledges. Orthographic means can be used to express the author's pragmatic evaluation of a message and to determine the social status of the addressee. In Russian similar means include the difference between the capital and small letters (Вы и вы).

STRUCTURE AND INTERACTIVE STRATEGIES . Russian orthography on-line tutorial ORF can be used independently by students, high-schoolers and other users. Linguistical filling of ORF includes over 50 rules and 500 exercises in Russian orthography (orthogram Е/И, Н/НН,З/С, Ч /Щ, Ь, О/Е and etc). Software complex ORF includes the following structure elements: 1) base of rules; 2) base of exercises for each rule; 3) base of phrases and remarks to sustain the dialogue.

Each designation in the base of rules has the following attributes: part of a.word (root, prefix, suffix, ending); part of speech (noun, adjective, verb, participle, verbal adverb, adverb, numeral, pronoun, particle, conjunction, preposition); orthogramme (all orthogramms, Е/И, О/А, Н/НН, etc.) text of the rule; number of the rule.

This structure provides multiple entry to the base of rules and makes it possible to systematize the rules according to the different reasons (root orthogramm, orthogrammes in prefix, etc.) Interactive strategies intercourse with the system is sustained by a special base of remarks.

Structure of the program makes it possible to use it in information-reference, tutorial and control modes. Multiple entry to the base of rules, ramified system of exercises, dynamic design, communicative varieties of dialogue remarks provides for parity principle in intercourse with the system.

This very version of the course uses the mutually simple compliance Rule-Exercise. Future developing of the system would be realized in implementation of the multiple communication Text-Rule.

Information for a programmer. The complex is developed by means of Clipper 5.0 compiler and uses PC of IBM PC/XT/AT type and compatible; main memory not less then 512 Kb.

THE CEILIDH COURSEWARE SYSTEM

STEVE BENFORD, EDMUND BURKE, ERIC FOXLEY, NEIL GUTTERIDGE,
ABDULLAH MOHD ZIN
Learning Technology Research
Computer Science Department, Nottingham University, UK
E-mail: ltr@cs.nott.ac.uk

We describe the Ceilidh courseware system, distributed to approximately 40 universities in the UK and elsewhere, and supported by the UK government's "Teaching and Learning Technology Programme" (the "TLTP"). The system provides tools for the administration of academic courses, and the automatic marking of student work, particularly in programming courses.

The Ceilidh system in various forms has been in use at Nottingham since 1988, where it is used in two departments to support courses in both C and C++ programming with classes of up to 160 students. The system marks up to 400 student exercises per week, and administers all of the course data.

This paper first summarises the student view of the system, showing the different user interfaces available. We then look at the facilities provided for tutor and teachers, which include looking at overall class metrics (essential when the teacher is not hand marking work) and plagiarism test. Finally we look at some of the educational implications of the introduction of the system.

Overview of Courseware

The three main areas involved in what we refer to as courseware are:

1. The administration of courses. Under this heading we include:

- Monitoring individual student progress.
- Monitoring overall course progress.
- Informing tutors of relevant information.
- Detecting and reporting defaulting students.
- Distributing course information.
- Collecting on-line (e.g. word processed) work.
- Returning on-line work.

2. The assessment of student achievement. Marking student work in various forms such as:

- Computer programs in various languages.
- Multiple choice questionnaires.
- Question/answer exercises.
- Essays or reports.

3. The presentation of information to students.

The traditional role of CAL has been in the presentation of information to a student, with the speed of progress determined by the student, and with different routes being followed depending on the student's choice and on the system's assessment of the student's progress.

The Ceilidh project aims eventually to cover all these areas, and at present covers the first two comprehensively, but the third only minimally.

We will distinguish between the Ceilidh system itself, and the courses which run under it.

PROLOGUS LEARNING ENVIRONMENT AND ITS APPLICATIONIN INFORMATICS TEACHING

DMITRY P. BOGOLUBOV, MARIA L. GAINER
Informatics Centre
Moscow State Institute of Electronics and Mathematics (MIEM)
3/12 B. Vuzovsky str., Moscow 109028, Russia
E-mail: bogolub@plb.icsti.su

Keywords: logic programming, Prolog language, informatics teaching, learning environment, hypertext.

Recently logic programming and Prolog has been introduced into Informatics courses not only at universities and colleges, but also at schools. Prolog is used as a means for knowledge representation and problem solving. Being an efficient tool for logical thinking development, it can serve as the basic programming language in the Informatics courses for high school students, as well as humanitarian university students.

Long-term experience in teaching has shown that it is necessary to provide Russian learning environment for Prolog which could not only be a convenient programming tool, but also support teaching courses.

For IBM-compatible computers a first version of logical programming learning environment PROLOGUS has been developed. It includes a Prolog interpreter supporting the Edinburgh version of the language, multiwindow shell, hypertext and structural editor, debugger, textual and graphical tracers, and teaching subsystem.

The interpreter allows to use Cyrillic in constants, variable names, functors, etc. In addition to the Edinburgh standard it supports graphical predicates and real numbers arithmetics. The interpreter features either English or Russian version of built-in predicates. It can operate in single solution and multiple solution modes and supports dynamic data bases permitting to assert and to retract both facts and rules.

The multiwindow shell supports windows for the editor, context comments, textual and graphical tracers, prompt, and dialog.

The structural text editor in addition to conventional functions of entering and editing Prolog programs is capable of syntax checking and context-sensitive prompt.

The debugger is used for recognizing three kinds of mistakes in Prolog programs: the program generates incorrect result, the program does not generate any result, the program does not terminate.

The tracers can also be used for localizing and correcting mistakes. However, their main aim is to illustrate program execution that helps a novice programmer in realizing Prolog procedural semantics. The graphical tracer represents the program execution process as an AND/OR tree. The tree can be visualized at runtime, the trace information being stored for subsequent visualization. If the tree is too large, it is possible to scroll the screen.

The mechanism of context commenting allows to escape using bulky comments inside the program text by carrying them out to separate windows and visualizing synchronously with the corresponding program fragments pointed to by the cursor.

The teaching subsystem is an efficient aid for novice Prolog programmers. Its main component is computer book of problems containing texts of Prolog programs, solutions, certain advices, a list of mistakes and misconceptions. The teaching subsystem also includes the TEACHER module which is capable of choosing a teaching strategy, getting solution, recognizing mistakes, giving advices and explaining how to solve the problem if it is necessary.

A lesson in the computer book of problems is divided into three stages: demonstration of the original task Prolog model, problem modification, and independent solving of similar problem [1]. The computer book of problems uses a hypertext representation of the lesson that assumes storing

facts, rules, quests and comments, representing the knowledge of some microworld, at the hypertext network nodes. Every path in the network defines a Prolog model of the corresponding task. Students study the suggested examples of problem solutions, modify the Prolog models using hypertext editor, and conduct experiments over them. Then problems similar to those considered at the first stage and featuring the same logical structure are suggested for independent solving.

PROLOGUS environment has been tested at the MIEM Physical and Mathematical School and at the Faculty of Applied Mathematics. Now it is a part of software support for the Informatics textbook for 10-11 classes that has been elaborated in MIEM.

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DIDACTIC AND PLAN RECOGNITION IN INTELLIGENT HELP SYSTEM

FATIHA BOUSBAHI & BRIGITTE DE LA PASSARDIERE
E-mail: bousbahi@masi.ibp.fr

Keywords: didactic, help, plan recognition, tutor, help strategies

As software applications become more complex, the need for adaptive user supports is increasing. User supports provided by traditional help (Hard-copy manuals, on-line help systems) are not sufficient [Sill90]. Problems arise in accessing the information as well as in understanding it. One way to address this problems is through intelligent and didactic help systems which provide users both active and passive support and take into consideration their different skills (secretary, novices, casuals, etc.).

In this communication, our research on didactic help and its relation with plan recognition is first exposed. Then we describe our system S.A.R.P., a Help System based on Plan Recognition, developed in PDC Prolog and applied to word processing's domain. We are mainly deal with ways to provide didactic, active, and personalized help.

Didactic is the science which studies the knowledge transmission mechanisms. These mechanisms are function of topic (training to data processing is different from commercial one) and public (to train an engineer is not the same to train a secretary).

Before defining any mechanism, a didactic study of application's domain situates specific problems in the domain. It detects the difficulties that user meets when he works on his application and tries to know the origin of them.

The didactic study of a domain in help systems has then:

- As aim: to improve user's knowledge by providing an adapted and personalized help.
- As functions: to identify specific problems in the application's domain and to detect user's errors.
- As method: to turn into account errors and to organize help items.

The didactic analysis of word processing application's domain has enabled us to identify two main users' types and several types of specific problems in word processing concepts. The first type corresponds to users who have never worked with computer tools. We called them novices. The second one corresponds to users who have already had a contact with one or more computer tools (for instance, word processing, spreadsheet, etc.). We called them casuals. The types of problems specific to word processing concepts are defined as follow: execution of an operation (create, open,

copy...) on one or more objects (files, paragraphs, tables, characters...). An inquiry carried out with psychology students of first cycle at university, during their formation to use word processing, enables us to verify that novices meet deep conceptual problems and casuals have more operating difficulties. Moreover, we have find that the users avoided to use complex functions offered by the system and they did not try to optimize their work proceeding . We think they were afraid to have a failure or a dead end. The presence of a help system gives them more trust and it grounds them to go far in their know-how.

To correct these lacks and errors, the S.A.R.P. system uses a tutor which performs help strategies. These strategies try to ameliorate user's errors and difficulties by proposing a precise explanation according to their cause at a right time. But how the tutor can know the moment to act and the manner to do it? One way to answer these questions is to supervise the user's actions and then detect his difficulties. This method aims to recognize the user's plan.

The plan recognition is complicated by possible behaviours of the user. The user may execute two or more plans simultaneously, or he can abandon a plan and begin a new one. Even the user is planning anything. To solve these problems, some searches in this field formalize plan recognition method Kautz [5]. The plan recognition applied at intelligent help systems has:

- As aim: to identify user's needs.
- As function: to interpret user's behavior when tasks are performed in the application in order to detect beliefs, intentions and difficulties;
- As method: to watch over user's activities;

In word processing a task consists of elaborating a plan (an operation) and executing its actions (commands). So, the user's activities can be seen as the execution of plan. Hence, recognizing user's actions allows the help system to know where the user's needs must be answered. S.A.R.P. has three principal components: Interface, Knowledge Base and Help Engine.

Actually, the Help Engine of the system S.A.R.P. fills four tasks: it watches over user's activities, detects his intentions, identifies his needs and finally, plans an intervention to answer them. To achieve the perspectives of our research on active personalized and didactic help, we have also developed help strategies which enable the tutor to intersect at the right time.

AN OBJECT AUTHORING SYSTEM COMPILING REACTIVE ELEMENTS AND TUTORING STRATEGIES

MAHMOUD BOUFAIDA & PATRICK BARRIL

Laboratoire Methodologie et Architecture des Systemes Informatiques (U.R.A. 818 du CNRS), Equipe S.I.E., Institut Blaise Pascal, Universite Pierre et Marie Curie, 4 place Jussieu 75252 PARIS Cedex 05, France.

E-mail: boufaida@masi.ibp.fr

Keywords: graphical elements, tutoring strategies, authoring environment,Smalltalk, communication protocols, user interfaces

We present an authoring system allowing to specify and compile graphical interaction elements as well as tutoring strategies. The graphical elements are parts of the real time reactive interface. Instead, the strategies allow a long -term planning of the interaction. This work is a part of a larger project designing an authoring environment dedicated to computer science teaching and aiming to use some programming environment tools in the exercises of a courseware. With this system, a teacher writes and maintains an educational software through an oriented-object interface written in Smalltalk/V. This latter language is well suited for a modular and incremental design, and so, our system is extensible to other specification tools.

The pedagogical use of a programming environment in a tutorial requires the opening of several windows : each program corresponds to multiple presentations. Furthermore, for each window in the student interface, pedagogical events must be taken into account during the unfolding of the courseware, and so, we manage a multithread dialogue. Our system is a kind of generic tutor which distinguishes the dialogue from the teaching domain knowledge. So, the author can set up presentation resources and specify the dialogue between the machine and the student, without programming in Smalltalk.

The authoring system presents two styles of interface :

- Reactive graphical interfaces, using a toolbox of specific editors, ction elements.
- Textual acquisitions, in Prolog-like syntax for the definition of dialogue goals and tutoring strategies.

The articulation between them relies on the cooperation of several classes and on communication protocols. They support a distinction between pedagogical goals and exercises : it enables the author to use an exercise in more than one goal.

The compilation of the student interface elements is based on a net structure which is used as support for the definition and the execution of tutoring strategies : these strategies manage proper activation and control of these elements. A net node corresponds to a dialogue element or to a combination of these elements. Such a node may be a whole window divided in text views, graphics, menu. In order to achieve independency of domain knowledge, a node control obeys to protocols (for example : open, close, activate). For the author, each kind of node is associated to a specific editor. He can see links as prerequisite and postrequisite relationships : they define default strategies and allow him to test the dialogue before specifying more elaborated strategies. The network and strategies are respectively compiled in resources and plans for the student mode. An engine runs them during a courseware. A tutoring plan can request en element to send messages to diagnosis programs.

The tutoring strategies are divided in two layers :

- The predefined strategies (relying on the net links), for instance, for "breadth-first" or "depth-first" net traversal.
- The specified tutoring strategies are combinations of tutoring primitives and tactics.

On the one hand, the primitives can be, for instance :

- Close a dialogue : it corresponds to the closing of a window.
- Suspend a dialogue (a window) for activating the next (or the previous) window.
- Summarize : it builds a survey of the student path through the courseware.

On the other hand, the tactics like helping, explaining or remedying, depend on the teaching domain and so delegate messages to domain and diagnosis specific parts.

This system has been developed on a computer PC/AT 386. It provides, at the moment, eleven kinds of general purpose interaction element editors, not taking into account elements dedicated to program edition, program debugging or data inspection.

HYPERTEXT AND HYPERMEDIA SUPPORT FOR THE LEARNING OF PROGRAMMING: THE CLEM AND BRAQUE SYSTEMS

TOM BOYLE, MARTYN DAVIES, JOHN GRAY & BRIAN WENDL
Faculty of Science and Engineering
Department of Computing
Manchester Metropolitan University
Chester Street, Manchester M1 5GD, England
E-mail: tom@uk.ac.mmu.com.sun

The aim of this tutorial is to describe and illustrate two major computer assisted learning environments for learning programming skills - the CLEM and Braque systems. Both these systems have been developed at the Dept. of Computing at Manchester Metropolitan University in England.

The first system, CLEM, is concerned with learning to program in the language Modula-2. It is a large system which has been extensively used by several hundred students at two British universities as a major part of their first year programming courses. The tutorial will first introduce the main design themes of the CLEM system. These are based on the CORE design approach - CLEM stands for the CORE Learning Environment for Modula-2. The CORE design principles provide support for a 'guided discovery' approach to learning. It aims to activate the kinds of learning strategies employed by children so effectively in learning natural language and applying these to the area of formal language learning. These design principles will be described and their application in the CLEM system fully illustrated. If time permits there will be a facility for direct hands on interaction with the system. The evaluation of the impact of CLEM in terms of student reaction and impact on formal unit results will also be reported.

The second system, Braque, focuses specifically on program design skills. It is thus complementary to CLEM which is concerned with learning the language itself. Braque consists of two main parts. The first part is a program design environment. This supports the user in developing a program design by allowing the unfolding design to be represented at different levels of abstraction. Three views of the program are presented from high level structural design down to low level implementation. These views are integrated so that changes at one level are reflected as appropriate at the other levels. The second part of the system is a hypermedia a tutorial introduction to program design. This demonstrates the design skills and techniques and supports the student in developing these skills. Braque was developed subsequent to CLEM and will be fully used for the first time with the 1993 student intake. The aim is to integrate the use of CLEM and Braque. This will provide a full computer assisted learning system for the acquisition of programming and program design skills.

COMBINING MICRO-WORLD AND TUTORING INTO A CONFIGURABLE PROGRAMMING ENVIRONMENT

Jean-Francois BRETTE
MASI, Institut Blaise Pascal - CNRS,
Boite 167, Universite Pierre et Marie Curie,
4 place Jussieu, 75252 Paris Cedex 05 FRANCE
jeff@masi.ibp.fr

Keywords : learning environments, ITS, programming environment, authoring tools, object languages.

PROBLEMATICS

We shall introduce here Pascal/V [Bret93], a Pascal programming environment under Smalltalk/V [Digi88], designed in the framework of the FORCE project (Format Objet pour la Representation des Connaissances Educatives) , which aims to develop specific tools for computer science courseware authors.

This teaching domain is privileged because the computer is both medium and subject of the learning. One avoids so the delicate problem of simulating a behaviour from a reality model : the dynamic phenomena observed by the student during the execution of a program are the ones we want to teach.

Yet, the majority of intelligent tutoring systems or Pascal diagnosis modules [Weng87] consider only program writing problems with the associated source code analysis, neglecting the observable behaviour of the running program.

Moreover, most programming environments are designed for development and badly adapted to the specific teaching problems : they involve notions too close to the implantation (hexadecimal addresses, correspondence with the generated code - sometimes optimized by the compiler - and not with the source code, ...) and are not configurable (therefore they don't fit to the student's level).

Our work was guided by the idea of giving the author the ability of incorporating a pedagogical and configurable programming environment into an intelligent tutoring system, in order to combine the constructivist point of view of micro-worlds [Piag59][Pape80] to an explicit tutoring aspect. This combination allows the degree of constraint of the environment to vary, the general purpose being to go from a very guided environment to a very free one.

FOR THE STUDENT

The environment tools offer the student a didactic approach and an ergonomic presentation of programmation concepts reputated to be difficult to understand (loops or function parameters for example). The choices follow lines adopted in sessions grouping professors of University of Paris (Pierre et Marie Curie) and the person responsible for Didactics in Computer Science at the University of Paris (VII). Contrarily to the development environments, this environment overlooks the implantation details and focuses on the design of program : the student observes the program behaviour and handles it through its source code.

The basic presentation of Pascal/V is the Pascal debugger, allowing the step by step execution and interactive debugging of programs : the procedure activation is visible, a balloon indicates the result (true or false) of the last executed test, global variables are accessible through a specific submenu, ... A loop unfolding, with context saving, allows the student to come back inspecting different loops : assertions can be more easily introduced because the student can verify them at several levels.

Pascal/V is made up with a compiler enabling analysis, running and debugging Pascal source code, and a display tools box. The parting, issued from Smalltalk, between the abstract model of a Pascal running program and its presentations [Barr93], allows the reification of all dynamic phenomena and the elaboration of various interactions.

FOR THE AUTHOR

The presentations and tools usable by the student correspond to a situated choice of the author. Indeed, he can configurate the interface depending on the exercise and the student's level he assumes (or wants to verify). Thus, an exercise easy to solve with a certain tool may require more skills without that tool ; contrary, why surrounding a beginner with a lot of sophisticated tools if he needs only very few of them ? Prohibiting or limiting the tools depends on pedagogical strategies and aims. One of our prospects is to incorporate to the courseware a student representation (this is in development) which will take part to the configuration.

Moreover, we offer to the author the ability to put a breakpoint in a program and to associate a dialog to it (setting an exercice or calling the student's attention to a specific point with an extra presentation for example). The author can ask the student "How many loops...", "Which value...", and, using the right tools, show the answer to the student (unfolding the loops by displaying their superposed windows,...). He can also propose an assertion and let the student verify it. Thus, the exercises range is not limited to set a problem and to diagnose the student's program.

CONCLUSION

So this is a preliminary work in the FORCE project for the development of situated help depending on a student's representation and pedagogical strategies defined by the author. Particularly, Pascal/V is designed to take benefit of authoring tools developed in the FORCE project allowing to specify display resources, tutorial strategies [Bouf93] and qualitative diagnosis [Barr90].

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VISUALISATION VS. TRANSFORMATION IN A COMPLEX DOMAIN: SUPPORTING PROBLEM SOLVING AND LEARNING IN PROGRAMMING

SIMON P. DAVIES

Department of Psychology, University of Nottingham, University Park, Nottingham, NG7 2RD, UK.

E-mail: spd@uk.ac.nott.psyc

There currently exists a certain degree of controversy surrounding the provision of support for complex problem solving skills such as programming. One of the major debates has centred around the question of whether support for programming tasks should be provided by textual tracing tools (Patel, du Boulay and Taylor, 1991) or by tools which support the graphical visualisation of programs. The debate has more recently moved on to challenge the foundations of intelligent tutoring systems, by claiming that knowledge-based support for skills such as programming can be surpassed by fairly simple visualisation techniques which employ little or no domain knowledge (Eisenstadt, Price and Domingue, 1992).

However, the relative efficacy of visualisation and textual tracing has not been subject to serious empirical evaluation. More problematically, the arguments for and against visualisation and textual tracing do not seem to have any real basis in learning theory, nor for that matter in more general psychological approaches to skill development. In this paper the results of an experiment looking at the role of external knowledge sources in programming are presented. This experiment was concerned with the use of different forms of knowledge by novice and expert programmers, and

suggests that there are significant differences in the way in which programmers of different skill levels utilise information. In particular, novices seem to engage in problem solving behaviour that is characterised by transformations of the problem space. Here, the initial problem representation is transformed into a different representation, usually at a higher level (i.e., program to design representation). Moreover, this transformation typically involved converting a code-based representation into some form of visual representation. In contrast, experts are seen to focus much more upon the simulation of the general dynamics of the code, and this often involves the tracing of variables and other important code-related entities. In general, expert behaviour might be characterised as a textual to textual transformation, where different textual representations are constructed for different purposes. These findings suggest that different cognitive mechanisms may underpin these component skills and moreover, that different forms of support for these tasks may be appropriate. In particular, while novices appear to rely heavily upon visualisation, experts, in contrast, adopt a more textual and closely code-based view.

Hence, one might see the evolution of expertise as a dynamic process where different mechanisms are called into play as skill develops. One issue that has not been addressed by those who advocate different forms of support for learning programming relates to the evolution of such mechanisms and to the notion that leaning does not appear to be a simple linear process which demands similar, but possibly more complex forms of support for certain skills. This raises other questions which have a direct bearing upon ITS work more generally. For example, when teaching certain skills, should one adopt an idealised model of expertise to which students are guided, or rather, support the manifestation of different skills as and when they appear? This may suggest a more flexible approach to tutoring where different forms of representation, whether visual or textual, are employed under different conditions.

In the context of the present paper, we suggest that the differences in information use by novice and expert programmers may reflect a deeper set of psychological processes. This may imply that the debate surrounding different modes of information presentation in programming tutors is possibly founded upon too limited a view of the psychological mechanisms which underlie this task. It is argued that differences in information use by programmers may suggest that novices tend to focus upon a transformational view and that this may be a manifestation of developmental processes which have parallels elsewhere. For example, Greeno (1989) and others (Clark, 1993; Dartnell, 1993) have suggested that part of the process of becoming an expert involves the development of an ability to re-represent features of a problem space, thus enabling the problem solver to advance past situated or concretised processes to a more flexible mode of reasoning characterised by the use of multiple models and perspectives.

The experiments and analysis presented here suggest that a more flexible approach to learning is required and that the dichotomy between textual and visual support for programming may be over simplistic. We argue that those building systems intended to facilitate learning in the programming domain should be more aware of the conceptual changes which occur during learning, and in particular the development of re-representational processes. Our analysis suggests that such systems should not simply support one model of the learning process at the expense of others. As a consequence, we would argue that both visual and textual support are appropriate during different stages of learning. In particular, the analysis presented here suggests that visualisation may be more useful at early stages of learning while textual representations make take greater precedence at later stages. In conclusion, we advance a more general argument about the need to take greater account of theory in both the development and the implementation of intelligent tutoring systems (Davies and Castell, 1993).

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INTELLIGENT PROGRAM ANALYSIS AND TESTING TEACHING

IGOR M. GALKIN
Computer Center, Academy of Sciences
25 Scorina str., , 220072 Minsk, Belarus
E-mail: katkov@adonis.ias.msk.su

Keywords: program analysis, quality control, intelligent teaching

A computer support of teaching programming is an actual and intensively developing direction in the field of tutoring systems creation. A task of teaching methods and ways of program quality improving is more special, rarer been considered, but not less important. This task is connected with the consideration of different program characteristics, in particular, correctness of control and data flow, complexity, testedness, commentedness etc., which are defined by static and dynamic program analysis. Such consideration, in its turn, supposes some knowledge of a learner about not only basic constructions of programming language, but also about main (common for sufficiently large number of languages) program representation models, e.g. control flow, data flow and call graph. Besides, a support of this teaching process needs the availability of tools of automatical building and analysis of such models. Developing of such tools for real programming languages is quite a complex task.

The possibilities of support of intelligent teaching some program analysis and quality control aspects on the base of the approach [1] connected with a semantic net representation and usage of knowledge about a program are considered. This approach envisages various program features modeling by semantic nets and frame ones that allows to uniformly represent information about program features which is necessary for different kinds of program analysis. Program analysis actions are described by a set of appropriate rules and are based on construction and analysis of such models. The main tool of this approach implementation is Prolog.

Facts of program representation are obtained by different ways - from program source code under and after its syntactic parsing and on the basis of program execution data. Program state models are analyzed by execution of Prolog program, which includes an appropriate set of rules and queries.

Based on this approach, SAIL system [2] analyses static semantics and testedness of programs written in Fortran-77. The implemented version of SAIL system defines infeasible parts of code and latent cycles, reveals the usage of non-initiated variables and redundant assignments, checks up the usage of the variables declared and declaration of ones being used, reveals untested program parts and proposes available plans of testing, and also provides a user with various common information about program and its characteristics (in that number, by answering user's questions expressed in some subset of natural (Russian) language [3]).

SAIL system has double orientation: on professional software developers and students with some background in programming. In professional aspect SAIL supports programmers' activities in highly quality programs creation. In pedagogical aspect SAIL promotes to user's programming culture increasing and helps in learning of ways of program quality improving.

Main directions of further developing of SAIL are:

- Increasing of number of supporting programming languages (at the expense of appropriate program source code analyzers development and making more precise an analysis kinds totality for each concrete language).
- Increasing of number of deciding tasks (at the expense of extending of a set of used analysis kinds, testing criteria and coding style metrics).
- Increasing of number of languages for communication with system.
- Differentiation of the system for its two main directions, namely, its developing, on the one hand, as analysis, testing and maintenance tool for programmers, and, on the other hand, as means of teaching students basic technological aspects of highly quality program development.

Common SAIL system architecture allows easily to supplement knowledge about learning subject by knowledge about teaching strategy and about learner. Learner model and actions may be represented by Prolog facts and rules that may ensure flexibility and adapting of teaching process. Well known Prolog ability for natural language sentences parsing may promote to support a communication with a learner with the help of some subset of natural language.

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AN ITS TO HELP NOVICE PROGRAMMERS BRIDGE THE CONCEPTUAL GAP

YU HE, MITSURU IKEDA & RIICHIRO MIZOGUCHI
Mizoguchi Lab, ISIR-SANKEN, Osaka University-Suita Campus,
8-1 Mihogaoka, Ibaraki, Osaka 567, Japan
E-mail: he@ei.sanken.osaka-u.ac.jp

Keywords: Knowledge-based system for education, ITS, Programming education, Program understanding

The goal of our research is to build an intelligent tutoring system (ITS), which assists novices in the programming process. In this paper, the difficulties novices encounter while developing a program are analyzed, and the approach to help novices overcome them by appropriate tutoring strategies is presented. Based on them, an ITS for novice programmers is proposed.

Making the system to have the pedagogical capabilities like human tutors requires techniques and knowledge for diagnosing the understanding state of learners. Especially, it is very important to understand what difficulties novices encounter in the process of programming.

One of reasons why novices produce bugs and reach impasses while developing a program is the gap between concepts used in the everyday life and that used in the programming world. Concepts supplied by programming languages are dependent on the the general characteristics of computer systems and are described in the high level of abstraction. Because their knowledge about computer systems is insufficient, it is hard for novices to understand them and transfer their intentions in mind into the prespecified forms. Our major purpose in the system is to help novices bridge the gap as early as possible. To this end, it is necessary for the system to understand and represent the gap in some way.

Although a lot of efforts have been devoted to the research in ITS for novice programmers, less attention (except for Bonar's BRIDGE) is paid to the gap mentioned above. An ITS for novice programmers is required the following functions:

- To understand programs written by learners considering the relationship between concepts used in programming world and everyday world.
- To diagnose the gap and misconcepts in their minds while developing a program.
- To carry out effective instruction form filling the gap based on (1) and (2).

Our system is designed so as to meet these requirements.

In our system, the knowledge structure is organized in the three-layer hierarchy: a program model, an abstract model and a subject (requirement, specification) model for better communication between the system and learners. The abstract model is the intermediate layer which manages the relationship between the program model and the subject model. Each model consists of a set of devices, each of which represents a primitive concept in the model. The gap between the corresponding devices in different models and the misconceptions concerned with concepts of everyday world, which lead novices to make bugs are analyzed.

Appropriate tutoring strategies to help novice fill the gap are adopted. Remedial advices are given to learners while programming, in suitable time which is decided based on the information about the learners' understanding and the learning process. In order to make learners think by themselves, the strategies are carefully designed so as to generate various levels of hints from the abstract or indirect level to the concrete or direct level in order.

The gaps which novice often encounter while developing a program are grouped into several categories which are used as index to arrange programming problems. The following shows how our system works.

- In the program understanding module, bugs in the program written by learners are recognized, and represented in the device level (mal-use device, inserting-parts, missing-parts etc.).
- In the bug and misconception analysis module, the gap which is encountered by learners is identified with analyzing the difference between the correct knowledge and the learners' knowledge about the device structure, and then misconceptions which cause bugs are diagnosed.
- In the tutoring strategy decision module, appropriate strategies are selected based on the types of bugs and the kinds of misconceptions which have been diagnosed above.
- In the advice generation module, advices are generated based on the tutoring strategies chosen above and knowledge and information in the system.

All the tutoring activities are controlled by the control module which decides when and how to effectively interact with learners based on the information about the learners' understanding and the learning process.

THE ALGORITHMIC LEARNING SYSTEM PROJECT

OLGA KIRICHENKO
1, Derevjanko, Apt. #100, 310018 Kharkov, Ukraine
E-mail: kirichenko%office.kharkov.ua@relay.ussr.eu.net

Keywords: algorithm, basic algorithmic structure, "algorithmic map", learning system, knowledge, fairy tale, game, computer character, library of tests, learning medium, education process

Suggested system includes "constructor", consisting of the basic algorithmic structures such as simple sequence, selection and repetition. Any kind of processing, any combination of decisions, any sort of logic, can be accommodated with one or three control structures or a combination of these structures. The "constructor" is intended to create the play field in learning system.

To provide the teaching process visuality an algorithmical map based on idea of the playing fields for children's table games was designed. The resulting "Algorithmic Map" becomes the component of the learning environment and children acquire knowledge easily and naturally.

Moreover the system has the library of the tests and the game control block. All of these tests can be changed and added.

During the process of constructing the algorithmic map that preschool and junior school children best of all acquire knowledge from fairy tales and games, was taking into account.

By means of the designer the teacher creates an algorithmic map, necessary for the study of the definite material. The players follow the concrete algorithm step by step travelling along the play field which is a big algorithmic scheme and is built by a teacher.

Having answered successfully the pupil is getting into the computer games hall.

Suggest games develop logical thinking, intellect and ability to analyze situations and to make choice.

The desire to lead a "magic character" through the algorithmic map and achieve the aim as soon as possible makes the child do some preliminary thinking and analyzing.

The teacher become a friend and adviser and helps to overcome difficulties.

During the trip through the algorithmic map a child can compile tests for his friends or computer characters. Features and peculiarities of the behaviour of fairy tale characters are devised by the teacher while constructing the algorithmic map.

There are three kinds of computer characters algorithmic learning system. The first one is a "superman", who is right and correct always and everywhere. The second one is a "doubting person". He can be right and act correctly after a few attempt or clues. The third one is a "bad person", who chooses the wrong way always and everywhere.

The algorithmic learning environment of which is collaborated by this system information from different subjects in the frame of the fairy tale plot.

This system provides all conditions for effective study of different subjects and ensures stable interest of the pupils to a subject during the educational process.

TO SELECT HINTS WHICH MAKES A STUDENT RESUME PROBLEM SOLVING

KOICHIRO MORIHIRO, YU HE, MITSURU IKEDA & RIICHIRO MIZOGUCHI
Mizoguchi Lab. The I.S.I.R., Osaka University,
8-1, Mihogaoka, Ibaraki, 567, Japan
E-mail: mori@ei.sanken.osaka-u.ac.jp

Keywords : ITS, problem solving, strategy, hint, reminding, resuming

Introduction

Problem solving knowledge consists of knowledge for execution of problem solving and knowledge for strategy. Most of the research on ITS has been concerned with teaching domain-level problem solving knowledge [Wenger87][Twidale89] in which teaching strategic knowledge is made implicitly if anything is done. In this paper, we discuss tutoring of problem solving strategies dealing with them explicitly.

Usually, operation knowledge of strategy depends on a situation which appears in the process of problem solving. So that, to improve student's capability in problem solving, a tutoring system has to have some particular functions. In this research, our system has a module for activating student's thinking processes, which gives basic information to generate an effective hint making student resume solving the problem. This paper mainly deals with this module.

Summary of the System

Frequently, a student reaches an impasse because he/she cannot recall an appropriate strategy for problem solving. The system gives student an appropriate hint which leads him/her to the success in the problem solving. Then he/she is supported to learn strategic knowledge inductively by himself/herself [Morihiro92].

A tutoring system which supports a student forming the situation-dependent knowledge is required to realize some particular functions. In this research, to realize the tutoring process mentioned above, we designed the following four modules:

- Problem Solver: It provides other modules with correct problem, solving process for a problem.
- Strategy Identifier: It identifies the strategies which the student applied in his/her problem solving process.
- Activator of Thinking Process: It selects a strategy of which the system wants to remind a student and makes him/her resume solving the problem based on a student's strategy-structure and that of the solution.
- Hint-giving Module: It gives an appropriate hints to student, which reminds him/her of a target strategy.

In this research, the process of reminding a student of a strategy is decomposed into two stages. At the first stage, some keys in the situation remind him/her of an application of a strategy. The second stage is testing the strategy for effect. Activator of thinking process estimates the mental resources consumed by him/her at above two stages.

The reminding pattern is represented by triple of a strategy, a situation, and a key symbol in the situation and used for the estimation. A situation is defined as a set of nodes of the strategy-structure of solution. A reminding key is a characteristic symbol in a situation, which reminds a student of an appropriate strategy. The system hints the strategy to the student by presenting the reminding key which is represented in the system. A set of patterns are prepared in the system a priori.

A good hint for a student, who is facing difficulties, should be what reminds him/her of an appropriate strategy with a small amount of mental resources mentioned above. A hint given to the student supports his/her thinking. Typical hints generated are shown as following:

- Show a student the goal to which the target strategy is applied, point out its characteristics and make him/her consider the set of more specialized subgoals descended of the goal under consideration and points out their characteristics.
- Show a student the goals to be expanded by a target strategy and point out their characteristics and make him/her consider more abstract goal which conquers a series of operators which he/she applied up to that time. Then he/she is assisted to recall the target strategy on the bottom-up way of thinking.
- Show a student a reminding key in the impasse he/she faced and make him/her consider strategy which dissolves the impasse.

Concluding Remarks

We explained ITS for problem solving we are currently developing. A prototype of the system have been implemented.

To teach strategic knowledge, a human teacher gives a student suitable hints or presents him/her appropriate problems. The educational effect of the hints or problems provided to students largely depends on the situation at problem solving. By interpreting the situation, for example in which the student faces an impasse, our system determines a target strategy and a reminding key for it based on the resource estimation. Using these information, it can generate a suitable hint or selects out an appropriate problem adapted for the students status.

A remaining work is to gather the more reminding patterns and classify them into some categories from the cognitive viewpoints.

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ENVIRONMENT TO LEARN FOXBASE

ALEXANDER I. NAGAYUK
Applied Mathematics and Cybernetics Department
20-1, Malaya Kalitnikovskaya str., Apt. #101, 109029 Moscow, Russia
E-mail: nai@plb.icsti.su

Keywords: tutoring system, student model, teaching operations, database FoxBase, learn programming language, learning environment

There is an environment to learn programming language of FoxBase databases managing system on the computers compatible IBM PC. This environment concerns to a new class of educational systems [1], which is based on combination of self and control learning.

The work in this environment allow the students to use as the system FoxBase, so additional design of visual debugging programs and internal database presentation. Besides, environment's

database consists of group of test programs, which objectly demonstrate the work of FoxBase's instructions.

This environment is working out with taking into consideration it's modification to expert-tutoring environment [2]. Now is working out general structure of environment (figure 1), the main modules of which are: knowledge base, control block and interface unit.

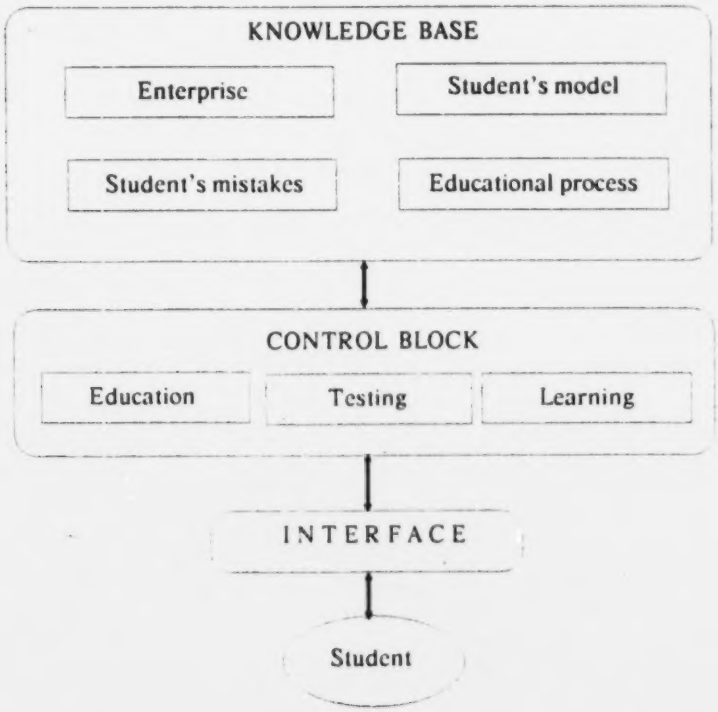

Figure 1. The structure of environment

Knowledge base

It includes the group of test programs, every of them directly demonstrates the work one of FoxBase's instruction. Environment gives possibility single-step work with these programs.

In the future knowledge base will consist of model of student, knowledge about universe of discourse, student's mistakes and educational process. There will take place all possible information about object of education and about student himself.

Control block

At this moment it includes learning and educational units:

- Learning unit: which implements student's activity for self-learning. It is powerful text editor with help of which user can debug any program in single-step conditional. Environment can catch mistakes in user's programs and inform him.
- Educational unit: made in simple variant at this moment. Student has possibility to trace running FoxBase's instructions in test programs and read help information about these instructions.

Control block will be added by testing unit, and every question of which will be connected which one or few knowledge's element about subject of education. The main task of control block is

building singe-step plan of education. Each step can demonstrate itself help information, question, task, test program or student's work in environment.

Interface unit

It is connection unit between the environment and the student. At this moment student has windows of text editor, variables and real screen of FoxBase, In the future this unit will implement all possible environment's functions of viewing database and educational process.

So at this time the environment is oriented on visual self-learning and intended for the support of designing user's programs. Later on the environment will be realize in whole volume, it will be make united system for learning, working out, debugging and running programs. Student will be given great freedom in actions, he will be able to choose tutoring topics and tasks, to ask questions, to receive adequacy diagnostics of his knowledge and skills. It will allow to develop his creative ability.

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PYTHAGORAS: HYPERMEDIA PROGRAMS AND SCENARIOS IN IMAGES

VLADIMIR V. PROKHOROV
Institute of Mathematics & Mechanics
Russian Academy of Sciences/Urals Branch
Ekaterinburg ,GSP-384, 620219 Russia
E-mail: prokh@imm.e-burg.su

Keywords: hypermedia, visual programming, pi-technology, CASE, object-oriented programming.

1. It's well-known that using of graphic, visual information representations greatly conducive to effectiveness of using of computer technologies. Unfortunately, this kind of information representation isn't widespread particularly through difficulties with convenient visual languages and with general conceptions of HCI. The above concerns both tool software (used for applied software development) and educational environment for students too.

2. PYTHAGORAS software complex is created at the Institute of Math. & Mech. of the Russian Academy of Sciences/Urals Br. The complex is based on the two main concepts developed at the Institute. The first one is the pi-technology of organizing of software and a language of an interaction [5, 6]. Pi-technology assumes using of general language as hierarchy of very small microsublanguages with own form representation of each.; the technology concept is associated with CASE and OOP ideas [1-3]. The second concept consists in orienting to the visual, graphic representations of instructions (formulas and algorithms) in the pi-schemes language [4] (this form concerned with a representation of an algorithm or a formulae by a tree-liked graph of a structure). Other kinds of specifications may be presents in most convenient form due to pi-technology using.

3. The PYTHAGORAS as educational environment (the other name of this version is piLOGO) can be used both for very young kids and for higher school students. The complex is reflected a concept of algorithms' executing by doer (executer) and superintendent (administrator): doer fulfill superintendent's commands. And there is areas on the screen for both superintendent (specifications area) and doer (executing area). The version oriented to enormous using not only graphics but animation too. And graph specifications (pi-schemes) haven't usual severe form, but they are showed with using some striking game metaphor (such as railway or catacombs picture etc.; teacher or student

can choose some metaphor of representation to their taste). Thus program preparing consists of creation of picture (such as railroad) using elements (icons) available. Main execution mode is a trace-mode; there are two animation on the screen in this mode when program running — a superintendent activity in his window and a doer activity in his window; a superintendent and a doer exchange messages during program executing. So, young student may not become aware of he is developing and debugging a program because his activity consists in creating of a catacomb plan or a railway etc. and in something else very liked to game. Note, a power of the language is similar to power of PASCAL but our language have ample opportunities connected with pi-technology using. With PYTHAGORAS a child or a youth can create complex software of hypermedia type.

4. Using of the PYTHAGORAS for software engineering implementation make it possible to develop multimedia and hypermedia educational environments on a base of graphical scenario, using of any existing software (pascal, data base system, graphics editor etc.) for modules creating. This hypermedia, multilanguage program seems as united scenario. What is more we can use any additional equipment with simplest installing procedure. Thus the PYTHAGORAS make it possible to create educational software of higher class without substantial special preparation of designer.

5. Complex includes the following main components: (a) the editor of pi-schemes of algorithms (i.e. scenarios), (b) the compiler/interpreter of the algorithmic/functional language, (c) the visualizer of algorithms' executing, (d) the documenters of pi- schemes of algorithms (scenarios).

We have an experience of using of the technology and software in education of students of the Urals State Technical University; there exists an experience of using of the ones in kids' education and for the educational software development. This experience shows very high effectiveness of using of this approach.

6. This work is executing under support of Russian Fund of Fundamental Investigations.

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THE INFORMATIVE-TRAINING MEDIUM "TURBO C PROGRAMMING"

V. RYNGATCH, G. LATUL

Department of Mathematics and Cybernetics,
State University of Moldova, Kishineo, Moldova

Keywords: computer-based training course, learning, Turbo C, syntax, semantics, methods of programming, C Functions.

The informative-training medium "TURBO C PROGRAMMING" belong to the multifunctional computer-assisted courses for programming and gives the possibilities:

- To teach syntax, semantics and methods of programming in C (the mode "C Language");
- To receive the extended information about built - in functions of Turbo C (the mode "C Functions").
- To work in the integrated environment Turbo C for execution and debugging the programs (the mode "Turbo C").

In the mode "Language C" in every moment the work of the learner is controlled by one of the subsystems: Menu, Information, Question, Textbook and Experiment, the initialization of which is made by function keys.

The subsystem Menu permits to select the necessary teaching section. Hierarchically opening menus from one to three nested levels contains 80 sections on Turbo C programing. Every section is represented by branching training program. Choosing for studying any section, student pass directly to subsystem Information.

The subsystem Information creates visualization of training material of the chosen section in virtual window. Moving the virtual window on the display screen provides favorable conditions for information perception.

The subsystem Question controls the mastering of the training material permits to get context help during the thinking over the answer. From one to three levels of context help is provided. Checking questions and tasks suppose the free-constructed answers.

The subsystem Textbook gives the possibility to see on the screen the teaching aid on C language. The manual subject content and means for selection of necessary section are showed on the screen for providing these facilities.

The subsystem Experiment permits to execute separate instructions and the programs fragments in various conditions. Altering variables values included in instructions and executing them learner assimilate the C language instructions semantics in dynamic process.

In the mode "C Functions" unlike the standard means of contextual information of integrated medium the following is suggested for choice:

- The selection of functions from the menu which are systematized by their prescriptions but not of their belonging to definite file header.
- The possibility to search the description of functions by the incomplete name.
- The extended description of functions, including the peculiarities and methods of using in practical programming.
- The experimental study of graphics functions by means of setting the arguments and analyzing the results of their execution.

In the mode "Turbo C" the learner can do the input, correction, compilation, execution and debugging the programs in accordance with the user guidebook in Turbo C.

The teaching-systematic guidebook includes the teaching aid "Programming in the Turbo C" and "Learner's guidebook". Manual "Programming in the Turbo C" can be used irrespective of informative-training medium software.

The software is carried out on the base of computer-based course toolkit shell and for IBM PC compatible computers.

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